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NATIONAL AEROSPACE PLANE SPECIAL STUDY ON CREW ESCAPE PHASE IV, VOLUME II

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July 1990

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AEROSPACE MEDICAL RESEARCH LABORATORY
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FOR THE COMMANDER

Lt Col, DEPUTY

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13. ABSTRACT (Maximum 200 words)
The National AeroSpace Plane (NASP) Special Study on Crew Escape Phase IV has completed feasibility studies and analysis on a new escape system concept for single-stage-to-orbit flight vehicles. The concept, called the Hybrid Separable Forebody, employs an aerodynamically stable forebody which separates form the vehicle using a passive-active separation system (failure initiated, or crew initiated). The forebody provides safe crew descent to an altitude and velocity regime where crew ejection using conventional ejection seats is possible. Early conceptual design was completed under Phases I & III of the study. Additional feasibility analysis and design has been completed under Phase IV. Based upon these analyses and design studies three preferred systems have been defined. These are a Mach 20.0 system covering a large portion of the NASP flight envelope, and two Mach 6.0 systems covering critical flight test events. In addition to these concepts, a set of tools and technologies has been established which can be used for continued NASP escape system development, as well as for follow-on hypervelocity and other high performance vehicle programs. These tools and technologies include a flight phase/failure mode matrix hazard analysis method, a 6 Degree-of- Freedom (DOF) trajectory analysis program with drogue parachute and ballute modeling capability, a separation dynamics analysis code, a number of stability and control methods and systems installations, and a considerable array of separation system technologies.

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EXECUTIVE SUMMARY

Airbreathing, hypersonic aircraft offer the potential for extraordinarily enlarged flight envelopes which will range from greater than Mach 6 cruise on up to Mach 25 for Single Stage to Orbit. No previously fielded escape system has covered such a wide flight regime and this poses a challenge for providing escape coverage for operational military and experimental aircraft. The problem is exacerbated by the extreme design constraints associated with such aircraft: the impacts of aerodynamic, propulsion, and aeroheating characteristics are more closely coupled and have less operational margins than in any other class of vehicle designed. Weight penalties are also extreme, especially if the vehicle must achieve Single Stage To Orbit.

These problems are extremely critical for the National AeroSpace Plane (NASP) program and the X-30. An entirely new type of propulsion system is being developed for an experimental aircraft which has as its stated goal achieving Single Stage To Orbit. These flight regimes have never been explored, manned or unmanned. Providing a survivable escape capability is a critical element of the development program's success. However, survivable escape cannot be purchased at the expense of jeopardizing vehicle performance goals through excessive weight or integration penalties; nor require an extremely large test program which financially jeopardizes overall program viability.

With these stated goals, Rockwell, in 1986 under Company provided funds, evaluated a broad range of historical escape options for potential updates with current technology for application on the X-30 and follow-on vehicles. Trade studies indicated that no historical system could provide the degree of coverage desired without unacceptable weight, integration, cost, or schedule risks. Rockwell then developed the concept of an inherently stable separable forebody capsule combined with high performance ejection seats to provide wide envelope coverage at minimal weight, development, integration, and test costs.

The concept, as originally conceived, was to provide a forebody capsule which would separate from the vehicle in the event of a catastrophic explosion. Since the forebody capsule was comprised of the full nose section of the flight vehicle, descent was to be inherently stable to a relatively low altitude, low speed flight regime where the crew could be extracted in a high performance ejection seat. This concept is desirable for a number of reasons. Separation was to be accomplished through the force from the explosion of on-board hydrogen (fuel). This eliminated the need for weighty separation propulsion and clearance systems. By using a conical forebody, weight penalties associated with an Orbital Maneuvering System (if orbital coverage is mandated) and an Attitude Control System are minimized. Much of the weight inherent in conventional capsules is necessary to provide survivable recovery; such items associated with crash attenuation, propulsion, and recovery chutes are eliminated with our concept. Additionally, recoverable capsules do not always provide a high level of survivability after ground impact. They frequently tumble leading to severe crew injury or death; whereas, modern high performance ejection seats, when optioned within their operational envelope, provide extremely high survivability. Furthermore, much of the design, analysis, and testing of the forebody capsule could be bootstrapped off of the existing X-30 development program. Expensive tests associated with capsule recovery, or completely independent aerodynamic and related analyses are not required.

Thus the hybrid escape system concept appeared to offer an ideal solution to the escape problem, drawing upon the best available from both the capsule and ejection seat technology base. Based upon our results, the Armstrong AeroMedical Research Laboratory has since funded Rockwell, as a Special Study under the NASP contract, to more fully explore this and other options for NASP, and eventually for application to derivative aircraft.

The first three Phases of the Special Study were completed in 1988. Phase I of the program defined hypersonic escape system requirements in much more detail than Rockwell had done under company funds. Based upon this, successive levels of escape system coverage were defined, which were thought to come with increasing costs. These levels were:

1) Ground Operations Only,
2) Ground through Mach 3,
3) Ground through Mach 5, and
4) Ground through orbital.

In Phase II, a total of twenty-one candidate escape systems were defined for evaluation at these levels of protection. At each level of protection, the systems were formally evaluated and down-selected to a preferred system for that level of protection. (Two systems were left in the evaluation for Ground through Mach 5 operations.) For Ground Operations Only a rapid egress system was selected. Ground through Mach 3 used a supersonic ejection seat such as an updated Rockwell HS-1A. For Ground through Mach 5, the hybrid separable forebody system was selected along with an alternate: encapsulated ejection seats. For Ground through Orbital, the hybrid separable forebody system (with an Orbital Maneuvering System for reentry) was selected. Finally, these five candidate systems were evaluated. The hybrid separable forebody system for ground through Mach 5 was selected as the overall preferred concept. (Orbital capability could be added, at a weight penalty, as a fall forward potential if later analyses suggested that orbital operations are riskier than originally indicated.)

In Phase III, the basic separable forebody concept was refined, and further analyzed. Such refinement included further requirements of separation systems and more detailed internal characteristics of the system. Analysis included studies of anticipated blast overpressure (due to hydrogen detonation) using a hydrocode modelling program and methods for attenuating blast overpressures. Stability analyses on the original and a derivative configuration (having a flared rear section) yielded encouraging results. Static and dynamic stability analyses indicated that inversion of the forebody for reentry was required to provide the desired lift characteristics; however no divergent modes were evident, and crew accelerations appeared survivable.

Based upon these results, AL/CFBE sponsored a follow-on Phase IV Crew Escape Special Study. This study, documented herein, has as its goals to analytically demonstrate the concepts feasibility using more detailed techniques, prior to required empirical testing, along with substantial design development based upon the analyses. Five tasks accomplish these goals (Task V is currently underway):

I) Forebody and Flight Vehicle Initial Conditions;
II) Forebody Design Refinement;
III) Forebody and Flight Vehicle Separation;
IV) Forebody Flight Dynamics; and
V) Seat/Forebody Ejection Interaction.

A brief summary of the work which was completed under Tasks I through V follows. (In this summary Task II will be presented after Task IV, since it is based on Tasks I, III and IV. In the detailed task reporting following the summary, results are presented in the order of the tasks with Task V reported in Appendix A.)

It is important to note that the work presented herein defines not only a specific well-studied solution for providing wide envelope hypersonic escape; but defines a basic methodological approach, along with a set of supporting tools to develop other escape systems which rely upon a forward capsule. In that sense, the program has provided both the basis for survivable X-30 escape, and the technology and tool knowledge base to support any number of potential NASP Derived Vehicle (NDV) escape systems.

Flight Phase/Failure Mode Matrix, Vehicle Initial Conditions at Escape
(Task I. See page 9 for detailed results.)

Initial conditions at escape, along with types, severity, and likelihood of emergency conditions is a primary driver for escape system design. Task I of the study reexamined these issues in much greater detail than had been done in the first three Phases of the study, incorporating more recent NASP design data. A set of flight phases was defined which covered all planned X-30 test missions, including envelope expansion. Additionally, failure modes which might be experienced in these flight phases were defined to include both general types of failures associated with all aircraft systems, as well as those associated with the unique aspects of hypersonic flight and vehicles.

A tailored application of MIL-STD-882B was then applied to the failure modes within each flight phase to determine the severity of the potential failure, and its likelihood. These together determined a Hazard Risk Index, which essentially provides guidance as to whether or not to "cover" the hazard with some type of compensatory mechanism (such as escape.) Also as part of this assessment, potential means to counter each emergency were defined.

Worst case vehicle initial conditions at escape were also determined. These conditions were determined through modelling a loss of vehicle control failure caused by hard-over rudder/elevon failure. Optioning forebody escape at these initial conditions would require the largest Attitude Control and Stabilization System. Analyses of these worst case conditions then drove later analysis of the separation dynamics, and was the basis for sizing on-board Attitude Control and Stabilization Systems to provide survivable capsule trajectories.

Forebody and Flight Vehicle Separation
(Task III. See page 48 for detailed results.)

There were two primary objectives for Task III, analyze the effects of aftbody proximity aerodynamics and blast overpressure on forebody separation and trajectory, and further develop a viable forebody separation mechanism.

In order to determine the effects of blast overpressure and interference aerodynamic on the forebody during and immediately after separation, a new computer code had to be developed. The new code, Forebody Aerodynamic Separation Trajectory (FAST) is based on existing flight and test data derived from missile/warhead and space vehicle/external tank separations. For consistency with NASP and NDV applications, emphasis was place on modeling conical shapes ranging from 5° to 10°. With this data a 6 Degree-Of-Freedom (DOF) trajectory simulation was modified to include aftbody interference effects and blast wave effects. The final code has a self-generating aerodynamic database which covers Mach number ranges of 20.0 to 0.6 for normal or blunted cones of 5° to 10°. Mass properties of the forebody can be varied; specific, more detailed aerodynamic characteristics of the forebody (from simple conical shapes) can be included if desired. Blast overpressures of varying sizes can also be modeled.

Following code development, Rockwell applied the code to a generic 7° cone, to establish free flight (no interference) trajectories, then adding aftbody interference, and finally aftbody interference with a representative blast wave overpressure. These analyses were run at three different initial velocities: Mach 20, 6, and 1.5, at both nominal and adverse initial conditions. (The adverse initial conditions were defined in Task 1 as catastrophic control system failure resulting in hard-over rudder and stuck elevon.) Results of these eighteen cases were compared to determine if successful separation is achievable in light of the external influences and initial conditions, and to determine what, if any, special stability augmentation systems were required.

Results of these analyses indicated that interference aerodynamic effects decrease with increasing Mach number. Fore- aftbody shock interactions are

significant at Mach 5 and decrease at higher velocities. Crew accelerations are aggravated at the low Mach numbers; however no divergent roll, pitch, or yaw modes were found. Because of the accelerations on the crew, it was determined that some type of stability augmentation device would have to be implemented within the first five second of separations (e.g., attitude control system jets).

Blast wave effects were negligible. However, we did not parametrically vary the size of the blast modeled but selected what we (and outside government consultants) thought was a reasonable energy level (5.54×10^6 N-m). However, there is much uncertainty associated with the size of the blast wave, which Special Study program resources did not allow us to investigate. In future analyses this aspect of the separation should be further investigated to insure that structural components are properly sized, and to establish the limits of our conclusions regarding blast wave effects on trajectory.

The second major objective associated with Task III was to establish a preliminary separation system design based on examination and detailed evaluation of a wide range of candidate designs. Rockwell did this through an iterative process of concept definitions, expert evaluations, designs refinement, preferred concept selections, and airframe integration studies.

Separations system concepts considered relied upon mechanical, pyrotechnic, or structural geometry modification. Key issues used in establishing the feasibility of each separation system design concept were: ability to provide a rapid structural break, vehicle structural integrity, reliability, maintainability requirements, weight impacts, and development risks. Additionally, because of the novel structural concepts being used on the NASP, four basic vehicle structural concepts had to be accounted for in the design of the separation systems: Hot Structure, Fully Monocoque; Hot Structure, Semi-Monocoque; Thermally Protected Structure, Fully Monocoque; and Thermally Protected Structure, Semi-Monocoque. Hot structure is located on the vehicle mold line and subject to the high thermal loads associated with hypersonic flight. Thermally protected structure is located under the external mold line, protected by insulation and/or heat shields. Fully Monocoque Structure is a thin shell, load bearing arrangement which uses minimal substructure to support loads. Semi-monocoque structure uses internal substructure (such as longerons and frames). Local load concentrations would be associated with the arrangement of the substructure.

Many different separation system concepts were designed and evaluated, and broken into three general classes: passive (wherein a hydrogen explosion blast overpressure directly provides the force for separation), active (wherein separation is initiated by crew or VMS and carried out by mechanical or pyrotechnic means), and passive-active (which includes both types of separation). The active system finally selected uses a floating shaped charge (pyrotechnic) located circumferentially about the fuel tank at the separation plane. Thermal isolation is provided to prevent convective heating. The preferred passive system uses a pressure baffle located at the separation plane which would concentrate blast overpressure, at that point, associated with a hydrogen detonation. The vehicle structure located in front of the pressure baffle is reinforced to eliminate airframe fracture propagation at that point in the event of an explosion. (It should be noted that this passive system is designed to provide separation only in the case of a large catastrophic blast overpressure propagating from the tank to the forebody. No inherent weaknesses or adverse load concentrations are associated with the design. For other types of stresses and loads, the probability of structural failure at the separation plane should be no greater than other nearby structure.) The final evaluation of the systems indicated that a combined passive-active system is the most desirable; hence, we combined the preferred passive with the preferred active for this system.

Forebody Flight Dynamics
(Task IV. See page 71 for detailed results.)

Having established initial conditions (Task I) and explored expected fore- and aftbody interference effect during and immediately following separation, Task IV had as its goal assessment of the forebody free flight dynamics, including static and dynamic stability from Mach 20.0 through Mach 0.6. Two basic variants on the forebody were analyzed. Configuration refinement 1 used the Special Study Phase III extended length forebody, updated with recent NASP design trends. This configuration had approximately a 60% CG, based on structure and flight test equipment packaging. Configuration 1 used an Attitude Control System to provide the required stability for survivable flight. The roll angle was varied during the return trajectory, (using the ACS thrusters) to minimize trajectory time and provide safe recovery.

Configuration refinement 2 was approximately 45" shorter than configuration refinement 1. The structural arrangement of this configuration required less stringent assumptions about equipment packaging in order to get the required CG. Configuration refinement 2 used an Inflatable Decelerator System (IDS) in order to provide desirable aerodynamic characteristics (positive lift over drag ratio), inversion was not required. Inflated, the IDS provides a rigid aerosurface which can be tailored for the specific aerodynamics and stability requirements. A minimal ACS system (much smaller than for Configuration refinement 1) was required.

Analyses performed on the configurations included static stability analyses to determine the aerodynamic coefficients required for the 6 DOF trajectory analysis. Static margins for Machs 20.0 through 0.6 were determined, along with Lift-to-Drag (L/D) ratios and trim angle of attack (alpha). Dynamic stability derivatives for the configurations were also determined over the Mach range. Techniques used to perform the analyses included Aerodynamic Preliminary Analysis Program II (APAS II) runs and DATCOM calculations. Additional required calculations were based on the Unified Distributed Panel Program (UDP) and Hypersonic Arbitrary Body Program (HABP).

Static stability, and associated characteristics were similar for the two forebody configurations showing stability throughout the Mach range analyzed. Additionally, as mentioned above, trajectory analyses were performed on configuration refinement 2 with the aerosurface concept (IDS) installed. This required some modification of the configuration itself to provide the required IDS installation and aerodynamic characteristics. This tailored configuration refinement 2 (with the IDS) showed good static stability and was used in further trajectory analyses. (Configuration refinement 2, without the IDS, was briefly analyzed in one of the trajectory analysis cases; however, it was dynamically unstable and further study of configuration refinement 2, without the IDS, was terminated.)

A series of trajectory analyses were run on each forebody configuration to determine the dynamic stability of the configurations and determine minimal stability and control requirements based upon the initial conditions determined under Task I. Analyses included assessment of the bioaccelerations acting on the crew to ensure that no deleterious acceleration modes were experienced. Additionally, a drogue parachute analysis subroutine was implemented in the trajectory analysis program to assess low speed stability enhancements offered by a drogue parachute.

The basic trajectory analyses run were post separation using a 2-body 6 DOF program called CETAP (Crew Escape Trajectory Analysis Program.) The program was developed under the Special Study and is based upon validated Rockwell code used to model separation of the Space Shuttle from its external fuel tank. CETAP analyses were run for all configurations tested from Mach 20.0 through Mach 0.6.

A relatively comprehensive test matrix of CETAP analyses were run. Cases were run at Machs 20.0, 6.0, 3.0, and 1.5 to simulate catastrophic failures in various flight regimes. Initial conditions for the runs were varied to include straight and level flight and failure initial conditions derived from Task I. The effects of various control and stabilization devices (for the appropriate configuration refinements as described above) were then modeled. This included inverting the forebody about its velocity vector (inverted or heads-down flight) to get the desired positive Lift-to-Drag ratio (L/D), use of a drogue parachute, use of a ballute, and use of the IDS described above. This lead to a total of twelve detailed analysis cases.

Results clearly demonstrated the need for additional control and stability devices to provide survivable escape. The forebody, without any controls, essentially "dived" into the atmosphere building excessive dynamic pressure (Q bar) to 5,000 psf within the first 45 second of flight (from Mach 20). The assumed structural limit of the forebody is 2500 psf. The forebody also experience uncontrolled tumbling. The test matrix examined various types of control and stabilization. Two methods were deemed particularly desirable. One, using the longer forebody variant (configuration refinement 1) rotated the forebody lift vector about the velocity vector between 80° and 180° (semi-inverted flight) to provide safe efficient descent from high Mach flight regimes. As speed decreased below Mach 5.0, however, instabilities surfaced which were countered with a drogue parachute model. These analyses were done at various initial velocities with essentially the same conclusions. Control requirements were derived from these analyses which sized the forebody design refinements described below.

The second method deemed feasible was to use the IDS aerosurface device on the shortened forebody (configuration refinement 2). These analyses demonstrated that stable heads-up descent was possible; however an Attitude Control System would still be required to offset worst case initial conditions. Note though that the IDS/shortened forebody configuration did not require the use of a drogue for low speed stability.

Bioaccelerations associated with the preferred configurations during descent raised some concern over crew injury risk. Oscillatory profiles were found for the Gy and Gz axes. The amplitudes for the profiles were low in magnitude and frequency, rapidly damped, and not considered life threatening. Analysis performed at AL/CFBE has indicated, however, that some of the Gz profiles were unacceptable. This analysis is reported as preliminary and is continuing.

The Gx accelerations were not oscillatory, but did have a sustained negative component resulting from either drogue shock, the IDS and forebody drag (depending upon the configuration). Combining this -Gx component with the Gy and Gz profiles could result in relative body motion and mispositioning during ejection, both leading to increased modes of crew injury. The severity of these effects can be reduced by tailoring stability and control systems to increase profile damping, and by providing supplimental crew restraint systems. The effects of these multi-axis accelerations should be further investigated along with the methods for reducing severity (especially for crew positioning at ejection).

Forebody Design Refinement
(Task II. See page 22 for detailed results.)

The objectives of Task II were to update forebody configurations and establish their mass properties, define and size stability and control systems as required based upon the results of Task IV, and integrate forebody configurations with the stability and control systems and preferred separation system defined in Task III. The forebody design refinement task was performed concurrently with other tasks as required data was available. The end products of the task are the preferred escape system concepts based upon all of the results of the other three

tasks. As such, these results are presented here in the Executive Summary as a succinct summary of the end technical products from Tasks I, III and IV.

Initial effort for the task was to refine the forebody capsule designs based on recent Rockwell X-30 design efforts. Outer mold lines (from a Rockwell X-30 configuration) were maintained, while inner equipment packaging and forebody length were driven by Special Study requirements. A primary requirement (from Phase III) was to maintain a forebody CG of 60% or less to insure adequate aerodynamic static stability. Additionally, the internal geometry located the crew member (design eye) as close as possible to the CG in order to minimize the effect of forebody oscillations about the CG on the crew. Internal packaging of flight equipment, distance from most likely location of fuel detonation, estimated flight stability, location of the crew, and location of the forward landing gear within the forebody, combined with the requirement to maintain 60% or less CG then determined the length of the forebody capsule, and thus the separation plane.

Two configurations were established for study. Configuration refinement 1 was 680" in length. CG varied from 60% to 58.2% depending on the amount of expendables on board. The Design Eye position is at 432" (from the tip of the vehicle) with the 60% CG location being nearby at 408.03".

Configuration refinement 2 was a shorter version of configuration refinement 1. This configuration allowed a less restrictive internal packaging of flight equipment to maintain required CG; and thus might be considered "more generic." Configuration refinement 2 is 635" in length with a CG at 355.2" (approximately 55% with a full load of expendables.) This CG is somewhat further from the crew design eye.

In Task IV analyses, configuration refinement 2 was found to be dynamically unstable. Sizing an ACS to compensate for this instability would have been prohibitively heavy. However, by tailoring the aerodynamic characteristics of configuration refinement 2 with an inflatable static aerosurface (the IDS) stable descent was possible. Thus two viable configurations were defined configuration refinement 1 and configuration refinement 2 with the IDS. Stability and control systems required for each of the viable configurations are described below.

Stability and control systems considered included Attitude Control Systems (ACS), drogue parachutes, ballutes, and the IDS. The ACS, a system of carefully placed and controlled thrusters, provides the most precise and adaptive method of control. It is capable of providing the required semi-inverted flight for configuration refinement 1, and can provide damping torque required to counter an adverse roll onset rate imparted by the failure initial conditions at escape for both configurations (estimated in Task IV to be 1500 ft-lbs.)

For low speed stability, drogue parachutes were evaluated for use on configuration refinement 1. Drogue chutes are well understood and can provide low speed stability while reducing critical sink rate near the time of ejection, and thus increase the time the forebody is in the safe ejection envelope.

Both ballutes and the IDS (for configuration refinement 2) were investigated. The ballute allowed for heads up flight, but required additional roll stabilization and low speed stability augmentation (a drogue chute). The IDS is a device which attaches around the circumference of the aft separation plane changing the aerodynamic surface configuration (when inflated) of the forebody. RAM air is used to inflate the device, which becomes quite rigid. (A back up system can be provided for inflation if necessary.) The IDS system allowed for heads up with minimal additional roll stabilization. No additional low speed stabilization was required.

Multiple ACS system concepts were defined to meet the control and stabilization requirements. The two major variants were a three-axis system (roll, pitch, and

yaw of the forebody) and a single axis system, both controlling roll about the forebody velocity vector. The single axis system used a canted roll thruster scheme to roll about the velocity vector, as opposed to full three axis roll control of the forebody oriented about the body axis system. The single axis roll scheme eliminated roll thruster induced perturbations in vehicle trim, and thus, eliminated the need for compensating pitch and yaw thrust. This combined with re-sizing and re-definition of the system resulted in a substantial savings in weight for the single axis system as compared to the three axis system while still providing required control.

The refined system uses hydrazine as the propellant with back-pressurization being provided by an inert gas (helium). Hydrazine was selected based upon its superior thrust to volume performance. However, hydrazine is an extremely toxic substance and will require special handling and design of the system. (This has been safely done on other systems and is therefore considered acceptable.) Eight thrusters are included in the system.

For configuration refinement 1, the system was sized to provide full suborbital (defined as through Mach 20.0) and minimal critical event coverage (defined as through Mach 6.0). Critical events are defined as propulsion mode changes and other critical flight test events which cannot be gradually approached. (The specific Mach number which covers all critical events will depend on the specific configuration and flight test plan, and will likely vary somewhat from Mach 6.0.) The Mach 20.0 semi-inverted ACS system (configuration refinement 1) weighed 354.7 lbs. The down-sized Mach 6.0 semi-inverted ACS system weighed 163.9 lbs.

For configuration refinement 2 with the IDS, a minimal amount of roll control is required for damping both the adverse roll onset rate, and slight roll instabilities encountered during descent. As a result, the ACS system is considerably smaller. The Mach 20.0 system weighed 92.2 lbs, and the Mach 6.0 System weighed 86.8 lbs. Essentially the roll damping requirements are very similar, and thus only small weight penalties are required with the IDS system to provide full suborbital coverage (as compared to critical event coverage.) However, it should be noted that the IDS technology has more risk associated with it than other more conventional systems used for semi-inverted flight.

A drogue chute was sized and installed for configuration refinement 1 to provide the required low speed stability. The 15 foot drogue is composed of high strength Kevlar and can be deployed up to dynamic pressures of 2500 psf and Mach 4.0 The installed weight of this system is approximately 120.0 lbs.

The IDS system for configuration refinement 2, reduces the required size of the ACS system and negates the need for a drogue chute for low speed stability. The IDS system sized for the configuration provided a slightly positive lift-to-drag ratio, trimming the forebody at a slightly positive angle of attack. The IDS was sized to minimize safe return trajectory time; however, it can be sized to provide a specific cross range and down range capability. The IDS would be composed of Nextel jacketed Kevlar which can withstand temperatures up to 2200°F. Inflation is with ram air scoops with dry nitrogen providing a backup capability. The installed weight of the system is approximately 110.5 lbs, with a required volume of 2.6 cubic feet.

Finally, the preferred passive-active separation system was installed on each of the forebodies. As described above, separation would be passively performed by the blast overpressure by use of a pressure baffle, with tank reinforcement in the area in front of the baffle. This would concentrate the loads of a blast wave to separate at the desired plane. (However, no stress risers or other structural anomalies are associated with this arrangement. No additional failure modes are induced by such a passive separation system.) The active portion of the system is composed of a floating linear shape charge slightly forward of the pressure baffle. This would cause separation upon crew or system initiation, or could be used as a post passive separation "clean up" system to insure a smooth

separation plane. The installed weight of the passive active separation system is estimated to be about 170 lbs.

Preferred System Summary

To summarize, based upon extensive feasibility analyses and design studies, we have defined three preferred systems. Each of the systems can provide survivable escape within the constraints imposed by the NASP program. The systems are:

1) Mach 20.0 escape using heads up descent with the IDS/ACS combination,
2) Mach 6.0 escape using heads up descent with the IDS/ACS combination, and
3) Mach 6.0 escape using semi-inverted flight with the ACS/drogue chute combination.

The Mach 20.0 preferred system is based on a 500" forebody configuration (configuration refinement 2) which uses the described passive-active separation system. An IDS provides a safe heads-up descent trajectory and low speed stability. A minimal roll control ACS system provides roll damping from adverse initial conditions at escape, and roll stability during descent. The total installed weight of the system is estimated at 372.7 lbs. A Mach 20.0 system without the IDS (based on configuration refinement 1 with a Mach 20.0 sized ACS system for semi-inverted flight) was rejected as being prohibitively heavy.

Two Mach 6.0 systems covering critical flight test events were selected, based on each the the configuration refinements. The system based on configuration refinement 2 using the IDS/ACS combination is similar to the Mach 20 system described above. Slight differences in ACS propellant are realized due to the shorter total descent duration from Mach 6.0 as compared to Mach 20. The total system weight is estimated at 367.3 lbs, 5.4 pounds lighter than the Mach 20 system.

The second Mach 6.0 system uses an ACS system installed on configuration refinement 1 to provide damping of adverse initial conditions; and to maintain roll control to produce semi-inverted flight required for a safe descent trajectory. The same passive active separation system used in the other two preferred systems is used. A drogue chute is required for low speed stability. The total system weight for this configuration is 453.9 lbs.

Given that there is a negligible weight difference between the Mach 20.0 and Mach 6.0 systems using the IDS, the choice for further development is between the lighter weight Mach 20.0 system using the IDS and the Mach 6.0 system which relies on a larger ACS system and the drogue chute. The IDS relies upon riskier technology, and thus the trade for further X-30 escape system development is weight and performance vs. moderate technology risk.

Ejection Seat/Forebody Interaction Dynamics Analysis
(Task V. See Appendix A for detailed results.)

Initial effort for Task V was focused on developing the Seat/Forebody Interaction Dynamics (SFID) tool. This tool was built from an existing code originally used to analyze seat ejection from both the B-1B and the Space Shuttle. Used in conjunction with CETAP (used in Task IV), both programs proved to be successful in demonstrating seat and forebody trajectory dynamics during the ejection sequence. For consistency configuration refinement 1 using the bank angle command, ACS, and drogue parachute, and configuration refinement 2 adapted with the IDS were used in the analysis.

The SFID simulation matrix contained eight cases, each using initial conditions derived from the end conditions of CETAP simulations run in Task IV. Redundancies in the end conditions (such as in Mach, gamma, and relative velocity) were changed to broaden the scope of the Task V effort. Cases 1 - 4

simulated ejection from configuration refinement 1 which used purely inverted flight to maintain maximum lift. This was accomplished through a zero attitude error command (a restricted version of the bank angle command). Cases 5 - 8 simulated ejection from configuration refinement 2, which was held at a 0° bank, or purely heads up, using the same zero attitude error command.

Case-by-case results showed that seat ejection from both forebodies was feasible without adding to stability and control systems. Instead, the zero attitude error command (assumed generated by a 1,500 ft-lb ACS counter torque) was used to minimize forebody roll resulting from ejection catapult forces. From this, it was shown that both forebodies were adequately stable during the ejection sequence, and that no seat/forebody recontact problems were present. Moreover, the seats were reasonably stable within the 2 second simulation period (where recovery was assumed successful). Several of the seat trajectories indicated a full 360° roll during seat free flight which was attributed to the divergence rocket motor. Since the seats were assumed as off-the-shelf, no attempt was made to improve the seat stability models used in the analysis. In addition, results also showed that initial condition parameters such as Mach, altitude, and dynamic pressure could be extended to the edges of the assumed seat performance envelope without significant changes in forebody stability during ejection.

The acceleration profiles obtained in the Task V analysis were found to be consistent with previous analyses done for the B-1B. High amplitude oscillations found in the X-axis during relative seat/rail motion were identified, and concluded to be a product of the spring and damper coefficients used in the seat/rail model. Future refinement of this model was suggested for a higher fidelity account of seat/rail contact reactions. This refinement would result in overall lower magnitude Gx profiles.

Both the Gy and Gz axes were relatively uneventful with the exception of moderately high Gy shocks at drogue line stretch. The highest magnitude case, however, was not expected to pose a significant threat to crew safety. The Gz acceleration profiles were all very similar in time duration and total magnitude, and are were well within the manufacturer's specification for typical (qualified) ACES II thrust acceleration. In all, none of the acceleration characteristics found in the SFID analysis posed a major concern for crew safety.

The biothermal hazard due to side-by-side seat ejection was also assessed in Task V. Results of a test conducted by NADC on the A6-F showed that the thermal environment generated by a side-by-side sequenced seat ejection from static ground conditions could be safely tolerated by the crew. The NASP ejection scenario (and seating geometry) was similar to the A-6F case, with the added benefit that the NASP crew was assumed donned in full pressure suit gear (while Navy test manikins were donned in summer flight gear). Based on comparison to the Navy A-6F tests, the thermal environment generated by the sequenced ejection of ACES II seats from the forebody was not considered as a significant threat to the crew.

PREFACE

This report was prepared under Contract Number F33657-86-C-2127, Mod P00024, The National AeroSpace Plane (NASP) Special Study on Crew Escape Phase IV. Tasks I - IV commenced on 20 June 1989, with a completion date of 31 January 1990. Task V commenced on 1 February 1990 with a completion date of 30 June 1990. Preparation of this report revision commenced on 1 June 1990 for submission on 31 September 1990.

Analysis support for the Phase IV effort was provided by the following engineers from the North American Aircraft and Space Transportation Systems divisions of Rockwell International: D. Morgan, K. Ruggles and L. Fanning (trajectory and drogue parachute analysis); D. Olsen and C. Mc Kinney (aerodynamics); E. Minick and R. Shinkawa (mass properties); W. Pierson, C. Unger and J. Goad (stability and control); D. Weston (system safety), and C. Ackers (reliability). Separation dynamics code development and analyses was provided by A. Mansfield of Rockwell International's Space Transportation Systems Division in Huntsville, Alabama.

In addition to trajectory code and drogue chute analysis, D. Morgan was instrumental in establishing both the Crew Escape Trajectory Analysis Program (CETAP), and the Seat/Forebody Interaction Dynamics (SFID) code. His effort on upgrading and applying the SFID analysis tool was key to the successful completion of Task V.

Phase IV technical coordination, configuration systems integration and separation device preliminary design was provided by A. Bermudez of North American Aircraft.

Program Management was provided by Dr. G. Griffin of North American Aircraft.

The government contract monitor for this effort was L. Specker of AL/CFBE, WPAFB

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APPENDIX C

Aircraft Dynamic Simulation of
Vehicle Loss of Control Failure

This appendix contains the plotted output of the Aircraft Dynamic Simulation runs of Task I for the loss of vehicle control failure condition. The failure simulated was a 20° hard-over rudder combined with a stuck elevon. The Mach number initial conditions run were 0.6, 1.5, 3.0, 6.0, and 20.0. The tabulated values on the left margin of the time histories indicate the parameter value at the start and end of the run, as well as the maximum and minimum value with the associated time of occurrence. Parameter labels monitored are presented below. Refer to Task I of this report for further information.

ADS Label	Definition	Units
PSW	pitch failure switch	
MACH NO	Mach number	non dim
Q DYNAM	Dynamic pressure	lbs/sq ft
ALTITUDE	Altitude	ft
NZ(G'S)	normal acceleration	g's
ALPHA	angle of attack	deg
P DOT	Roll acceleration about principal X axis	deg/sec^2
Q DOT	Pitch acceleration about principal Y axis	deg/sec^2
R DOT	Yaw acceleration about principal Z axis	deg/sec^2
DTEO	Elevator deflection	deg
DTAOP	Aileron deflection	deg
DVTL	Rudder deflection	deg
PB	Roll rate about X body axis	deg/sec
QB	Roll rate about Y body axis	deg/sec
RB	Roll rate about Z body axis	deg/sec
NX(G'S)	Axial acceleration	g's
NY(G'S)	Lateral acceleration	g's
BETA	Angle of sideslip	deg
RSW	Yaw failure switch	
DEDOT	Elevator rate	deg/sec
DADOT	Aileron rate	deg/sec
DRDOT	Rudder rate	deg/sec
HMR	Right elevon hinge moment	in-lbs
HML	Left elevon hinge moment	in-lbs
HMV	Rudder hinge moment	in-lbs

Mach 20.0

POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=20.0 Q=1686.1

	TIME	PSW
START	0.0000	1.000
FINAL	1.5200	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000

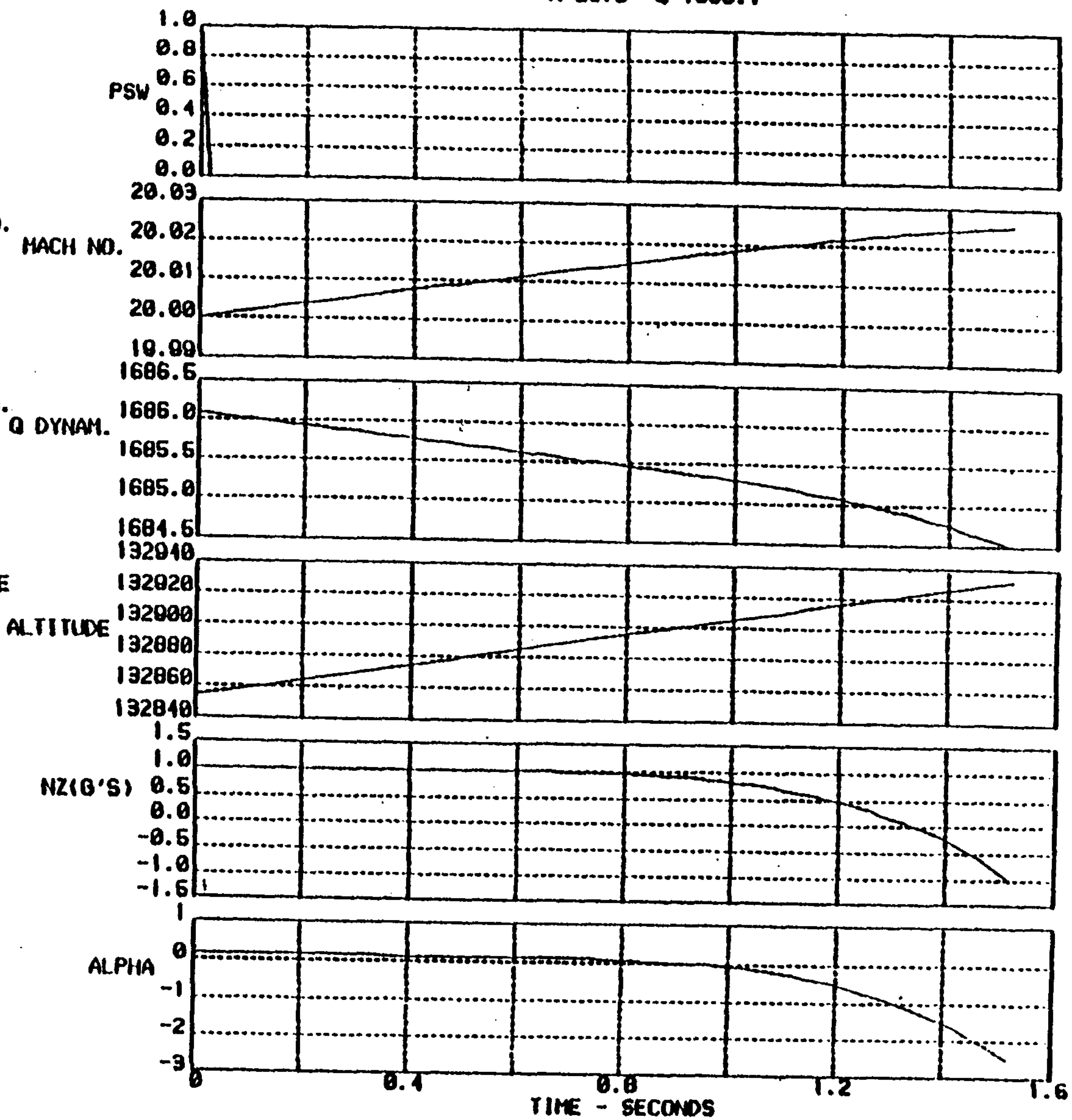
	TIME	MACH NO.
START	0.0000	20.0000
FINAL	1.5200	20.0254
MINIMUM	0.0000	20.0000
MAXIMUM	1.5200	20.0254

	TIME	Q DYNAM.
START	0.0000	1686.099
FINAL	1.5200	1684.504
MINIMUM	1.5200	1684.504
MAXIMUM	0.0000	1686.099

	TIME	ALTITUDE
START	0.0000	132854.22
FINAL	1.5200	132932.06
MINIMUM	0.0000	132854.22
MAXIMUM	1.5200	132932.06

	TIME	NZ(G'S)
START	0.0000	1.000
FINAL	1.5200	-1.027
MINIMUM	1.5200	-1.027
MAXIMUM	0.3800	1.002

	TIME	ALPHA
START	0.0000	0.16
FINAL	1.5200	-2.61
MINIMUM	1.5200	-2.61
MAXIMUM	0.0000	0.16



	TIME	PB
START	0.0000	0.00
FINAL	1.5200	89.58
MINIMUN	0.0200	0.00
MAXIMUM	1.5200	89.58

	TIME	QB
START	0.0000	0.00
FINAL	1.5200	-7.14
MINIMUN	1.5200	-7.14
MAXIMUM	0.1600	0.00

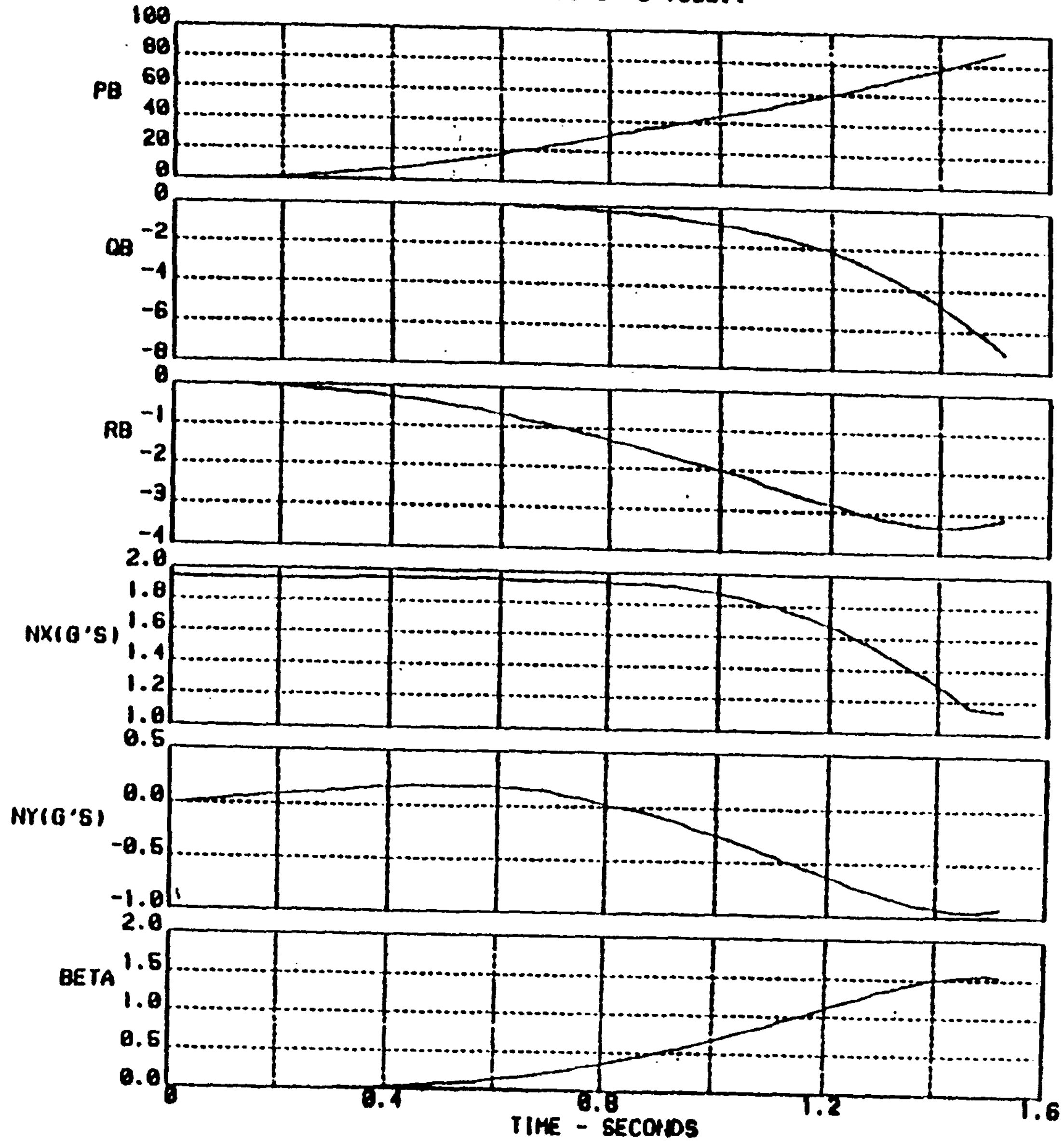
	TIME	RB
START	0.0000	0.00
FINAL	1.5200	-3.14
MINIMUN	1.4200	-3.34
MAXIMUM	0.0200	0.00

	TIME	NX(G'S)
START	0.0000	1.833
FINAL	1.5200	1.136
MINIMUN	1.5200	1.136
MAXIMUM	0.5000	1.841

	TIME	NY(G'S)
START	0.0000	0.000
FINAL	1.5200	-0.918
MINIMUN	1.4600	-0.948
MAXIMUM	0.5400	0.188

	TIME	BETA
START	0.0000	0.000
FINAL	1.5200	1.549
MINIMUN	0.0200	0.000
MAXIMUM	1.4800	1.564

POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=20.0 Q=1608.1



Mach 20.0

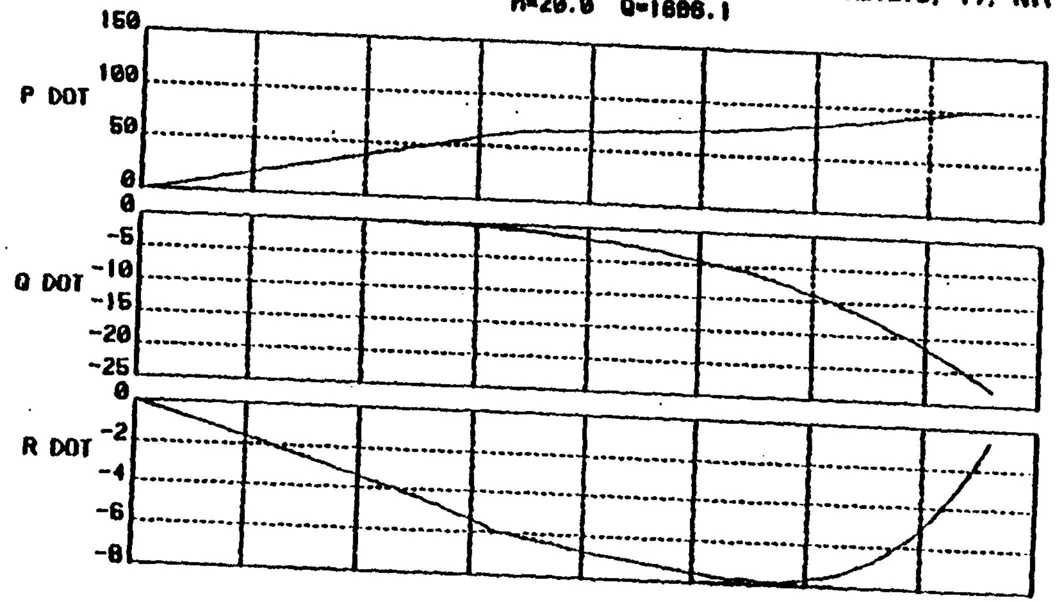
Mach 20.0

POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=20.0 Q=1606.1

	TIME	P DOT
START	0.0000	0.00
FINAL	1.5200	100.25
MINIMUM	0.0000	0.00
MAXIMUM	1.5200	100.25

	TIME	Q DOT
START	0.0000	0.00
FINAL	1.5200	-22.83
MINIMUM	1.5200	-22.83
MAXIMUM	0.1000	0.00

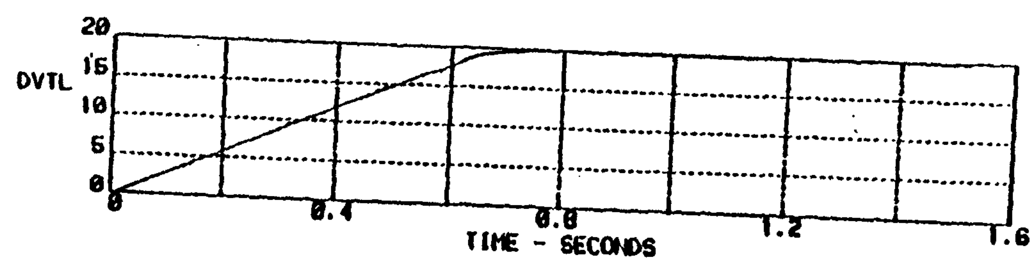
	TIME	R DOT
START	0.0000	0.00
FINAL	1.5200	-0.70
MINIMUM	1.1400	-7.86
MAXIMUM	0.0000	0.00



DTEO = -0.486314678E+01

DTAOP = 0

	TIME	DVTL
START	0.0000	0.00
FINAL	1.5200	20.00
MINIMUM	0.0000	0.00
MAXIMUM	1.2600	20.00



Mach 20.0

	TIME	RSW
START	0.0000	1.000
FINAL	1.5200	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000

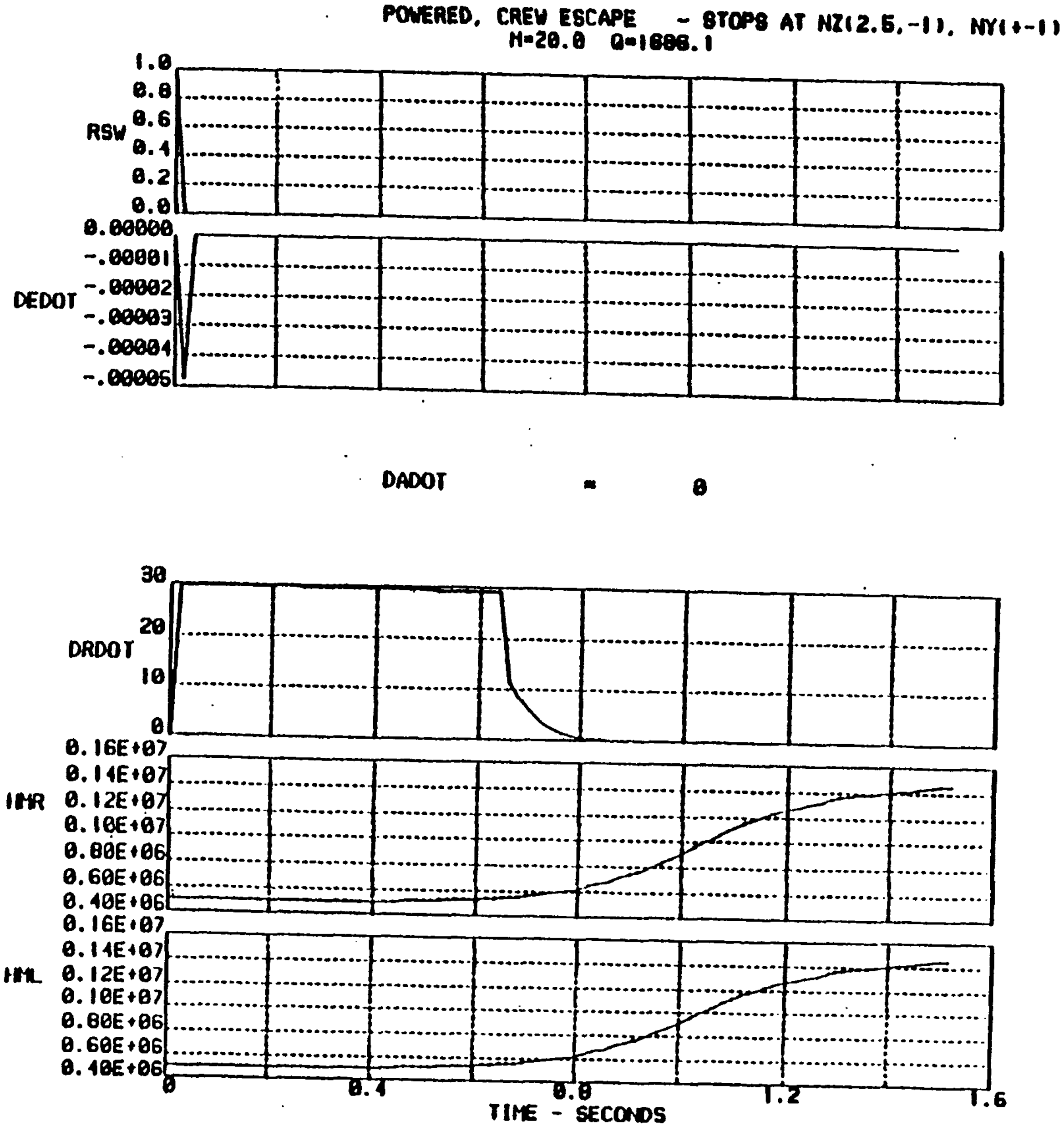
ZE raised at 4006(3)/43614

	TIME	DEDOT
START	0.0000	0.0000000
FINAL	1.5200	0.0000000
MINIMUM	0.0200	-0.0000477
MAXIMUM	0.0000	0.0000000

	TIME	DRDOT
START	0.0000	0.00
FINAL	1.5200	0.00
MINIMUM	1.2800	0.00
MAXIMUM	0.0200	30.00

	TIME	HMR
START	0.00000	.40933E+06
FINAL	1.52000	.14610E+07
MINIMUM	0.28000	.40768E+06
MAXIMUM	1.52000	.14610E+07

	TIME	HML
START	0.00000	.40933E+06
FINAL	1.52000	.14610E+07
MINIMUM	0.28000	.40768E+06
MAXIMUM	1.52000	.14610E+07



Mach 6.0

POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=6.0 Q=1126.61

	TIME	PSW
START	0.0000	1.000
FINAL	2.1400	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000

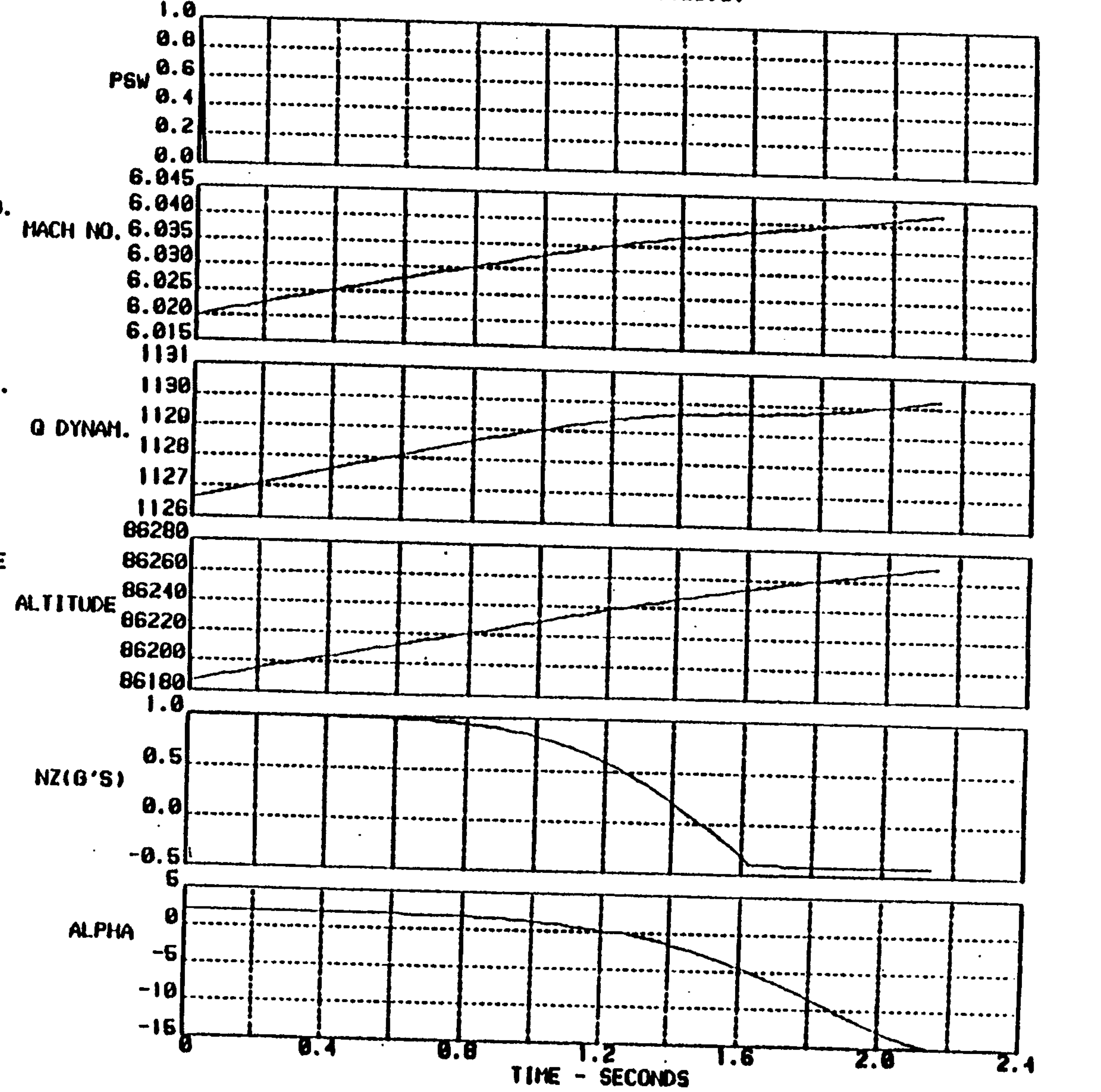
	TIME	MACH NO.
START	0.0000	6.02000
FINAL	2.1400	6.04212
MINIMUN	0.0000	6.02000
MAXIMUM	2.1400	6.04212

	TIME	Q DYNAM.
START	0.0000	1126.61
FINAL	2.1400	1130.28
MINIMUN	0.0000	1126.61
MAXIMUM	2.1400	1130.28

	TIME	ALTITUDE
START	0.0000	86186.83
FINAL	2.1400	86270.48
MINIMUN	0.0000	86186.83
MAXIMUM	2.1400	86270.48

	TIME	NZ(G'S)
START	0.0000	0.099
FINAL	2.1400	-0.405
MINIMUN	1.9400	-0.410
MAXIMUM	0.1400	0.099

	TIME	ALPHA
START	0.0000	2.05
FINAL	2.1400	-14.89
MINIMUM	2.1400	-14.89
MAXIMUM	0.0000	2.05



Mach 6.0

POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=6.0 Q=1126.61

	TIME	PB
START	0.0000	0.00
FINAL	2.1400	153.47
MINIMUM	0.0200	0.00
MAXIMUM	2.1400	153.47

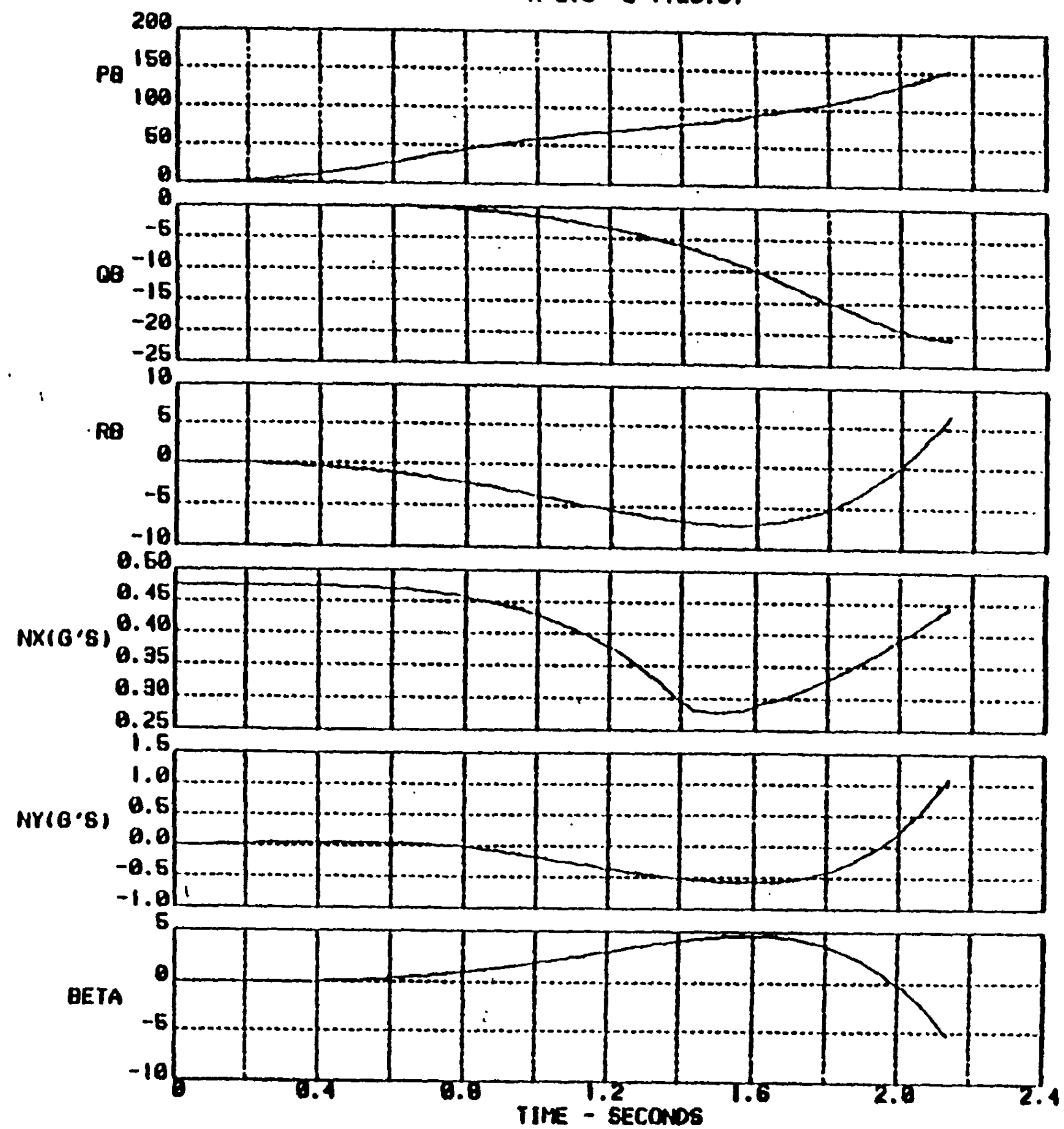
	TIME	QB
START	0.0000	0.00
FINAL	2.1400	-20.08
MINIMUM	2.1400	-20.08
MAXIMUM	0.0200	0.00

	TIME	RB
START	0.0000	0.00
FINAL	2.1400	6.66
MINIMUM	1.5400	-7.26
MAXIMUM	2.1400	6.66

	TIME	NX(G'S)
START	0.0000	0.4745
FINAL	2.1400	0.4417
MINIMUM	1.5000	0.2760
MAXIMUM	0.0800	0.4745

	TIME	NY(G'S)
START	0.0000	0.000
FINAL	2.1400	1.122
MINIMUM	1.6000	-0.591
MAXIMUM	2.1400	1.122

	TIME	BETA
START	0.0000	0.00
FINAL	2.1400	-5.36
MINIMUM	2.1400	-5.36
MAXIMUM	1.6000	4.78

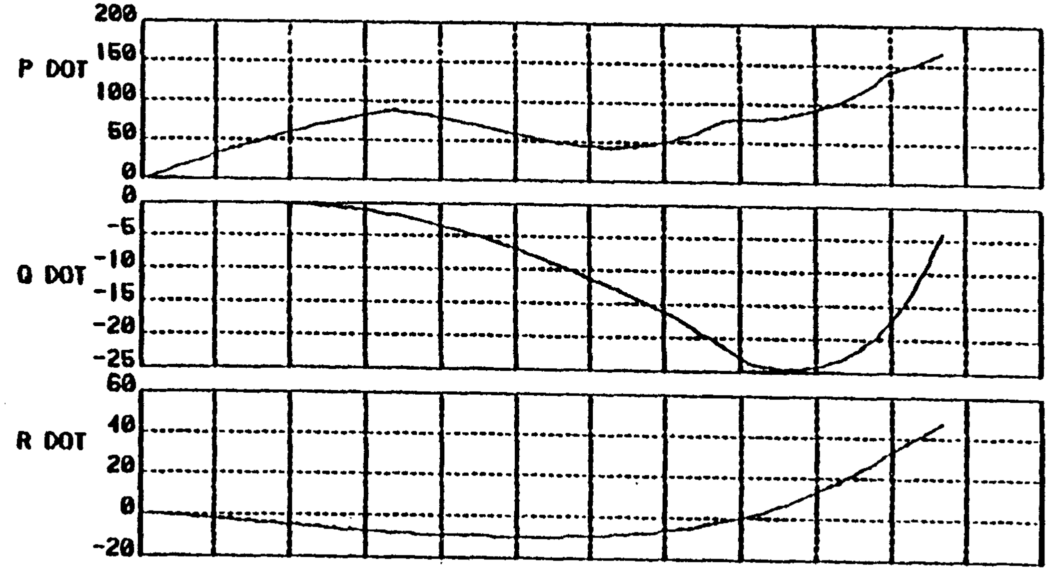


POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=6.0 Q=1126.61

	TIME	P DOT
START	0.0000	0.00
FINAL	2.1400	166.66
MINIMUM	0.0000	0.00
MAXIMUM	2.1400	166.66

	TIME	Q DOT
START	0.0000	0.00
FINAL	2.1400	-4.02
MINIMUM	1.7400	-24.64
MAXIMUM	0.0000	0.00

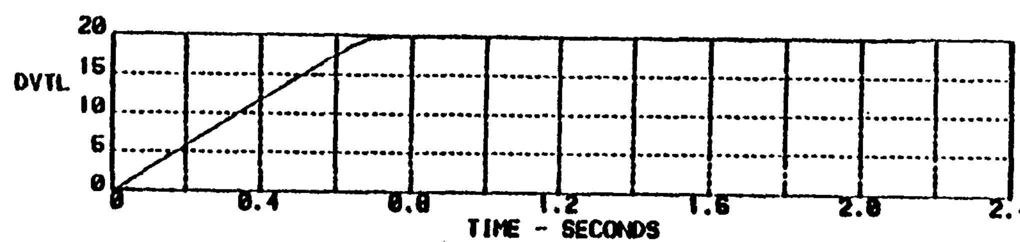
	TIME	R DOT
START	0.0000	0.00
FINAL	2.1400	47.30
MINIMUM	1.0400	-10.55
MAXIMUM	2.1400	47.30



DTEO = 7.36721

DTAOP = 0

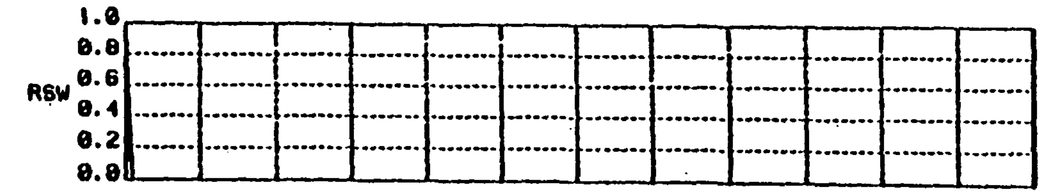
	TIME	DVTL
START	0.0000	0.00
FINAL	2.1400	20.00
MINIMUM	0.0000	0.00
MAXIMUM	1.2800	20.00



Mach 6.0

POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=6.0 Q=1128.61

	TIME	RSW
START	0.0000	1.000
FINAL	2.1400	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000



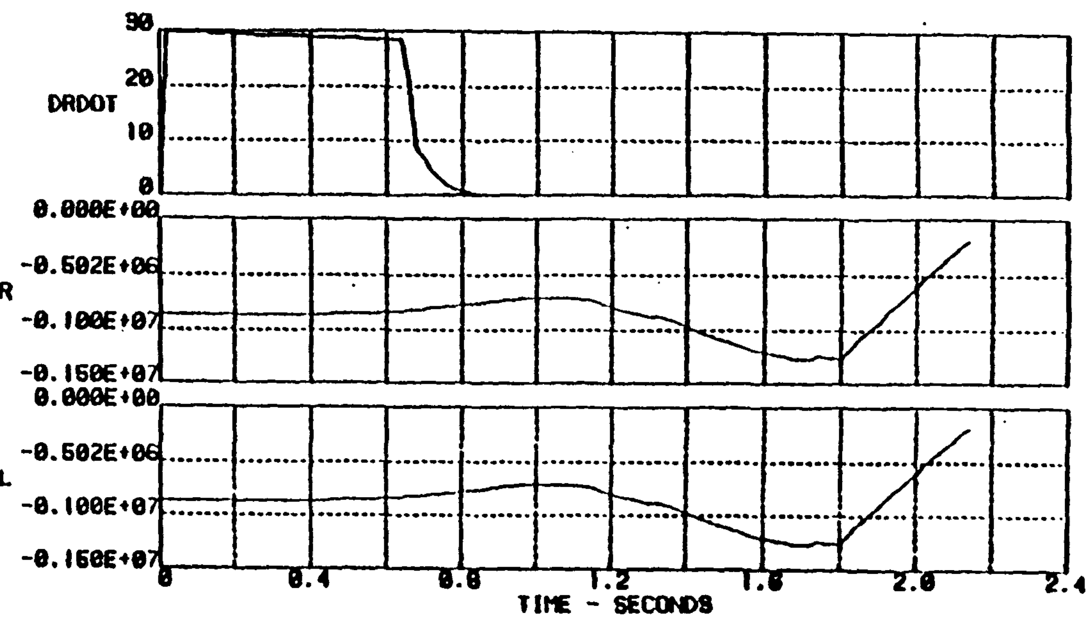
DEDOT = 0

DADOT = 0

	TIME	DRDOT
START	0.0000	0.00
FINAL	2.1400	0.00
MINIMUM	1.3000	0.00
MAXIMUM	0.0200	30.00

	TIME	HMR
START	0.0000	-.87804E+06
FINAL	2.1400	-.20044E+06
MINIMUM	1.7200	-.12858E+07
MAXIMUM	2.1400	-.20044E+06

	TIME	HML
START	0.0000	-.87804E+06
FINAL	2.1400	-.20044E+06
MINIMUM	1.7200	-.12858E+07
MAXIMUM	2.1400	-.20044E+06

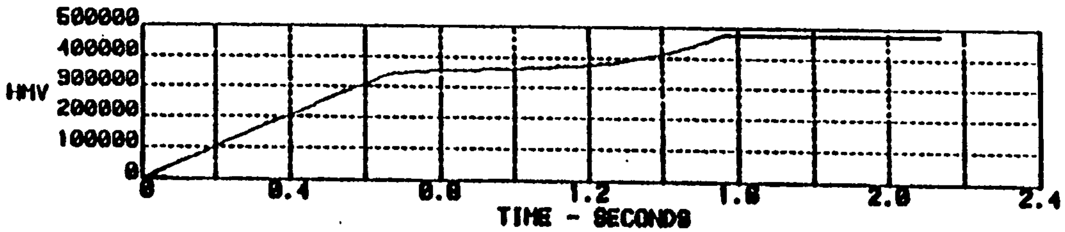


Mach 6.0

Mach 6.0

	TIME	HMV
START	0.0000	0.00
FINAL	2.1400	470371.37
MINIMUM	0.0000	0.00
MAXIMUM	2.1400	470371.37

POWERED, CREW ESCAPE - STOPS AT NZ(2.5,-1), NY(+-1)
M=6.0 Q=1126.61



Mach 3.0

	TIME	PSW
START	0.0000	1.000
FINAL	1.0200	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000

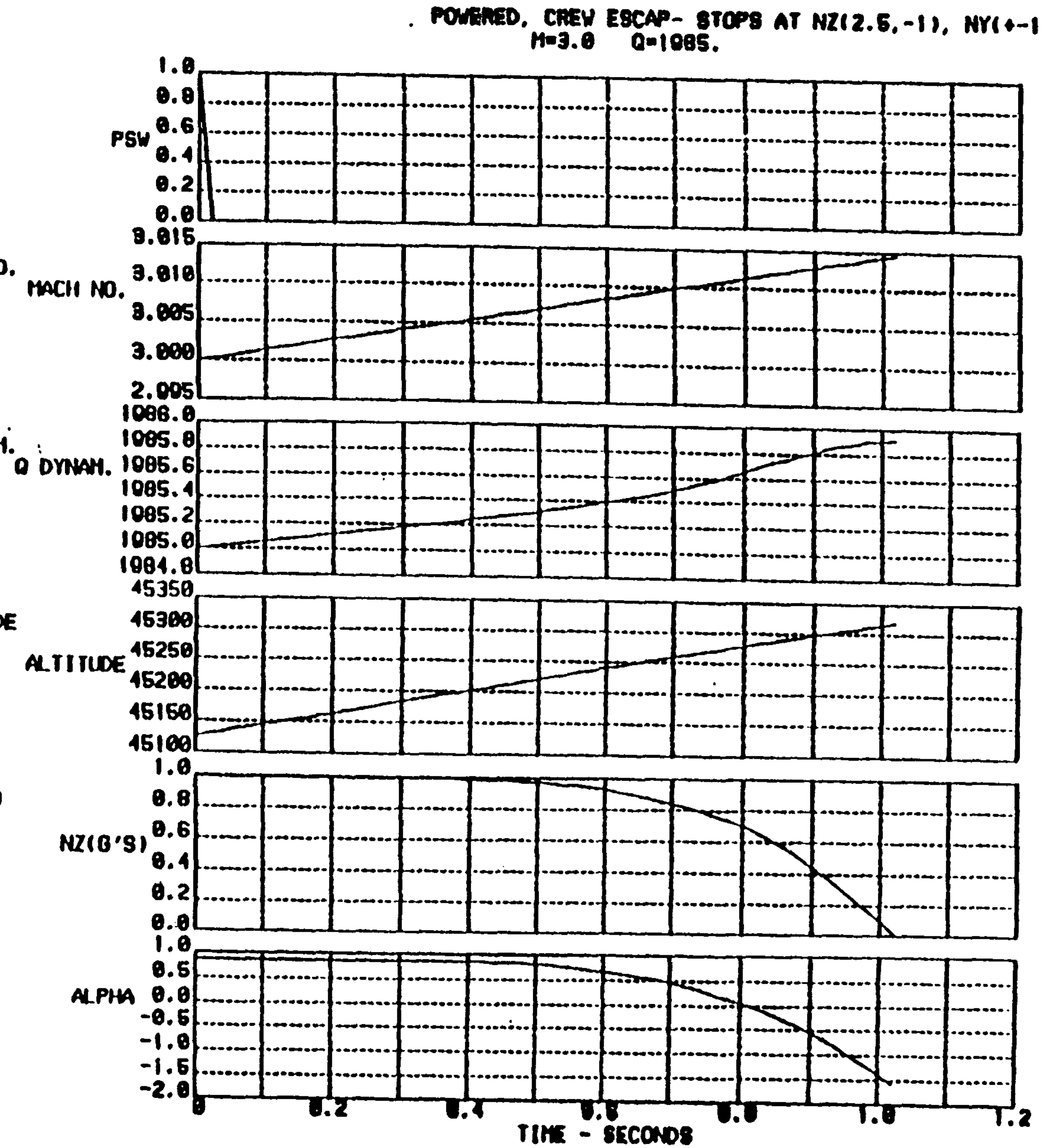
	TIME	MACH NO.
START	0.0000	3.00000
FINAL	1.0200	3.01463
MINIMUM	0.0000	3.00000
MAXIMUM	1.0200	3.01463

	TIME	Q DYNAM.
START	0.0000	1085.000
FINAL	1.0200	1085.010
MINIMUM	0.0000	1085.000
MAXIMUM	1.0200	1085.010

	TIME	ALTITUDE
START	0.0000	45124.09
FINAL	1.0200	45310.51
MINIMUM	0.0000	45124.09
MAXIMUM	1.0200	45310.51

	TIME	NZ(G'S)
START	0.0000	0.997
FINAL	1.0200	0.017
MINIMUM	1.0200	0.017
MAXIMUM	0.0000	0.997

	TIME	ALPHA
START	0.0000	0.898
FINAL	1.0200	-1.578
MINIMUM	1.0200	-1.578
MAXIMUM	0.0000	0.898



Mach 3.0

POWERED, CREW ESCAP- STOPS AT NZ(2.5,-1), NY(+-1)
M=3.0 Q=1085.

	TIME	PB
START	0.0000	0.00
FINAL	1.0200	49.15
MINIMUM	0.0200	0.00
MAXIMUM	0.8200	60.23

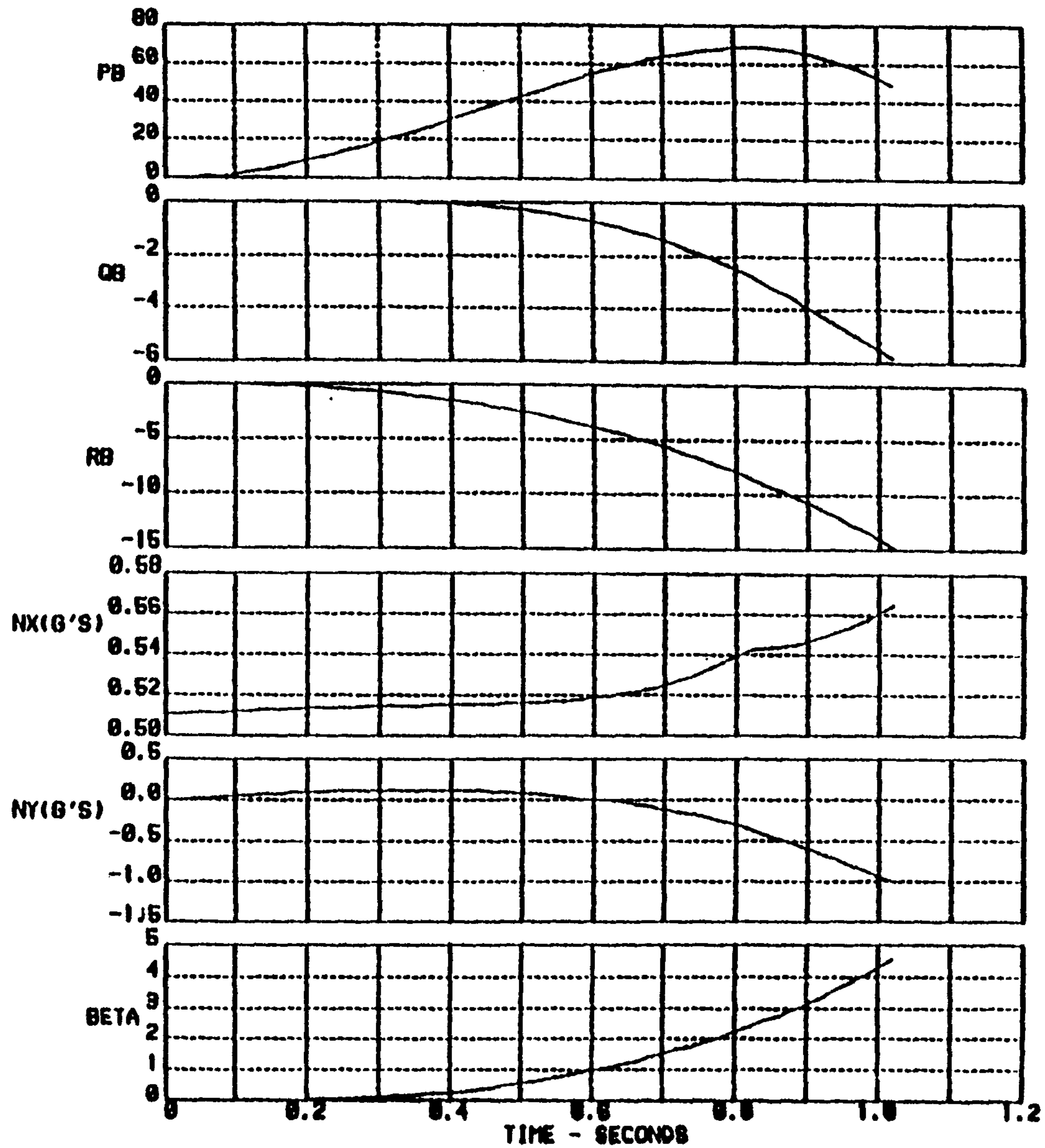
	TIME	QB
START	0.0000	0.00
FINAL	1.0200	-5.87
MINIMUM	1.0200	-5.87
MAXIMUM	0.1400	0.00

	TIME	RB
START	0.0000	0.00
FINAL	1.0200	-14.91
MINIMUM	1.0200	-14.91
MAXIMUM	0.0200	0.00

	TIME	NX(G'S)
START	0.0000	0.5097
FINAL	1.0200	0.5646
MINIMUM	0.0000	0.5097
MAXIMUM	1.0200	0.5646

	TIME	NY(G'S)
START	0.0000	0.000
FINAL	1.0200	-1.019
MINIMUM	1.0200	-1.019
MAXIMUM	0.3400	0.140

	TIME	BETA
START	0.0000	0.00
FINAL	1.0200	4.57
MINIMUM	0.0200	0.00
MAXIMUM	1.0200	4.57

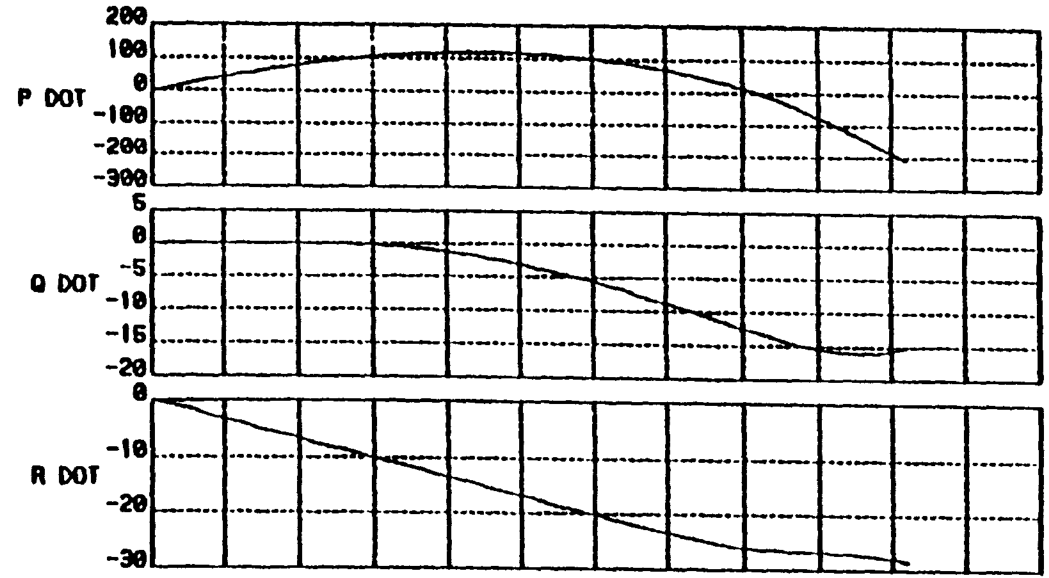


POWERED, CREW ESCAP- STOPS AT NZ(2.5,-1), NY(+-1)
H=9.0 Q=1985.

	TIME	P DOT
START	0.0000	0.00
FINAL	1.0200	-213.11
MINIMUM	1.0200	-213.11
MAXIMUM	0.4600	123.05

	TIME	Q DOT
START	0.0000	0.00
FINAL	1.0200	-15.31
MINIMUM	0.9600	-16.11
MAXIMUM	0.1000	0.02

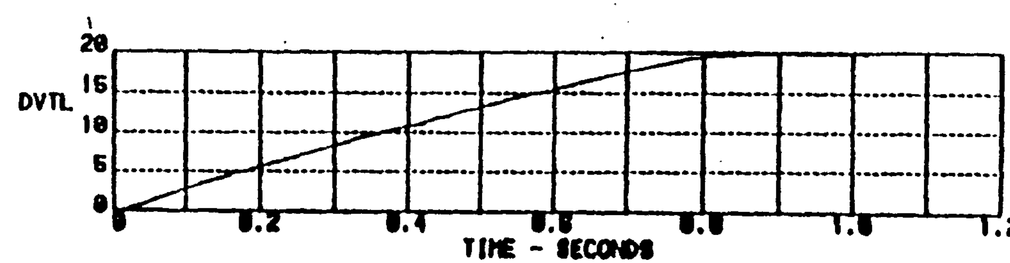
	TIME	R DOT
START	0.0000	0.00
FINAL	1.0200	-28.70
MINIMUM	1.0200	-28.70
MAXIMUM	0.0000	0.00



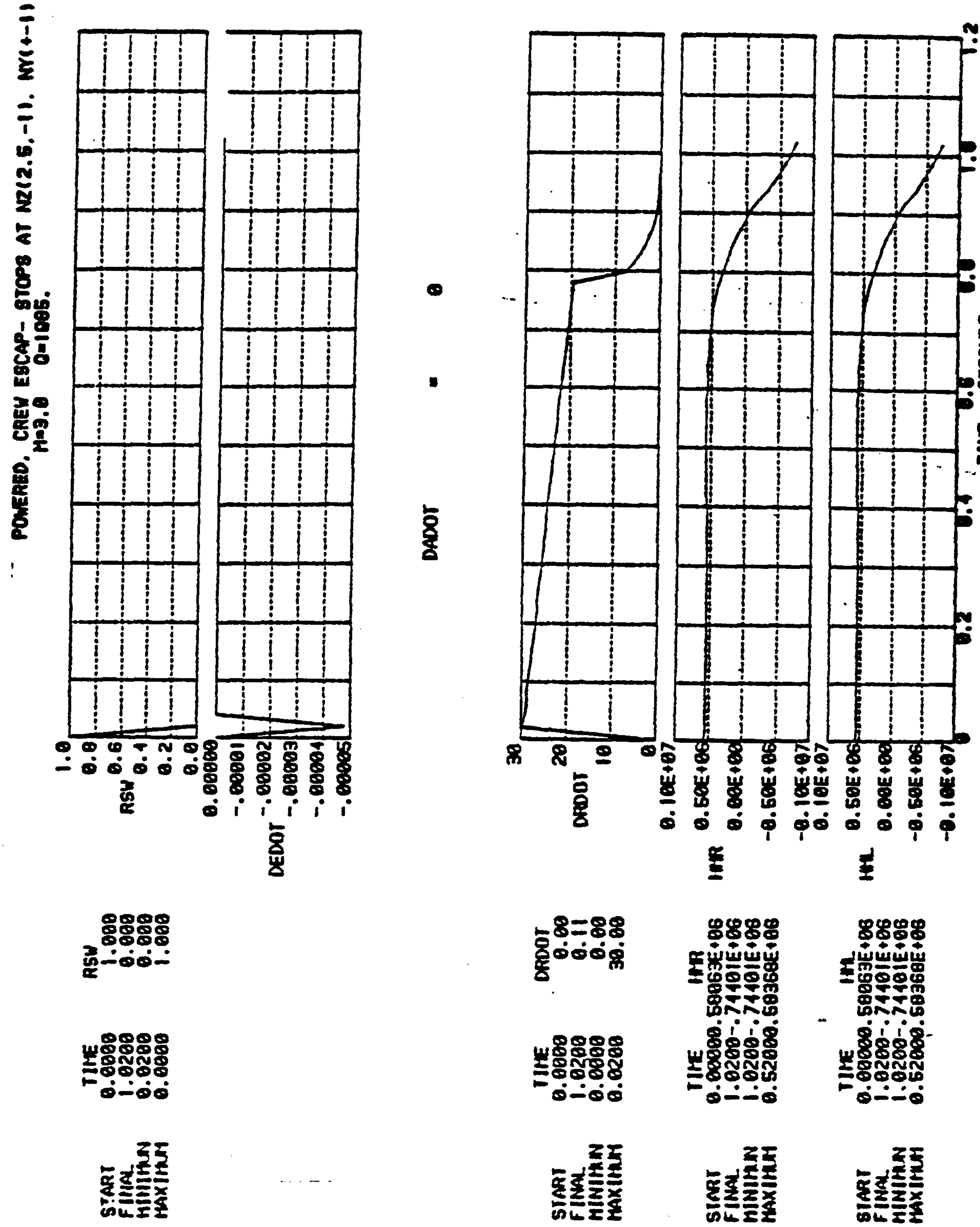
DTEO = -0.455665603E+01

DTAOP = 0

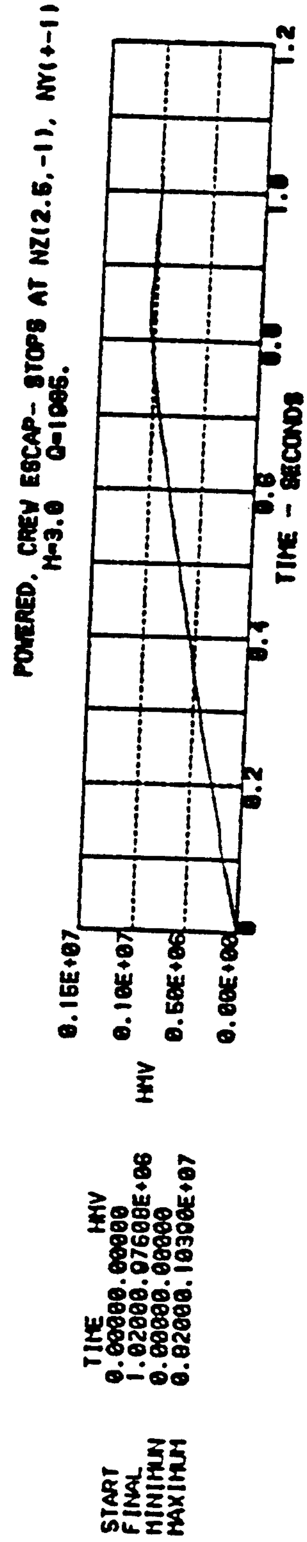
	TIME	DVTL
START	0.0000	0.00
FINAL	1.0200	19.99
MINIMUM	0.0000	0.00
MAXIMUM	1.0200	19.99



Mach 3.0


POWERED, CREW ESCAP- STOPS AT NZ(2.5,-1), NY(+-1)
M=3.0 Q=1085.
DADOT = 0
TIME - SECONDS
RSW
DEDOT
DRDOT
IHR
IHL
START FINAL MINIMUM MAXIMUM
TIME 0.0000 1.0200 0.0200 0.0000
RSW 1.000 0.000 0.000 1.000
TIME 0.0000 1.0200 0.0000 0.0200
DRDOT 0.00 0.11 0.00 30.00
TIME IHR 0.00000.58063E+06 1.0200-.74401E+06 1.0200-.74401E+06 0.52000.58368E+06
TIME IHL 0.00000.58063E+06 1.0200-.74401E+06 1.0200-.74401E+06 0.52000.58368E+06

Mach 3.0


POWERED, CREW ESCAP- STOPS AT NZ(2.5,-1), NY(+-1)
M=3.0 Q=1985.
TIME - SECONDS
0 0.2 0.4 0.6 0.8 1.0 1.2
HMV
0.15E+07
0.10E+07
0.50E+06
0.00E+00
TIME HMV
START 0.00000 0.00000
FINAL 1.02000 0.97600E+06
MINIMUM 0.00000 0.00000
MAXIMUM 0.82000 0.10390E+07

	TIME	PSW
START	0.0000	1.000
FINAL	1.1800	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000

	TIME	MACH NO.
START	0.0000	1.50250
FINAL	1.1800	1.51056
MINIMUM	0.0000	1.50250
MAXIMUM	1.1800	1.51056

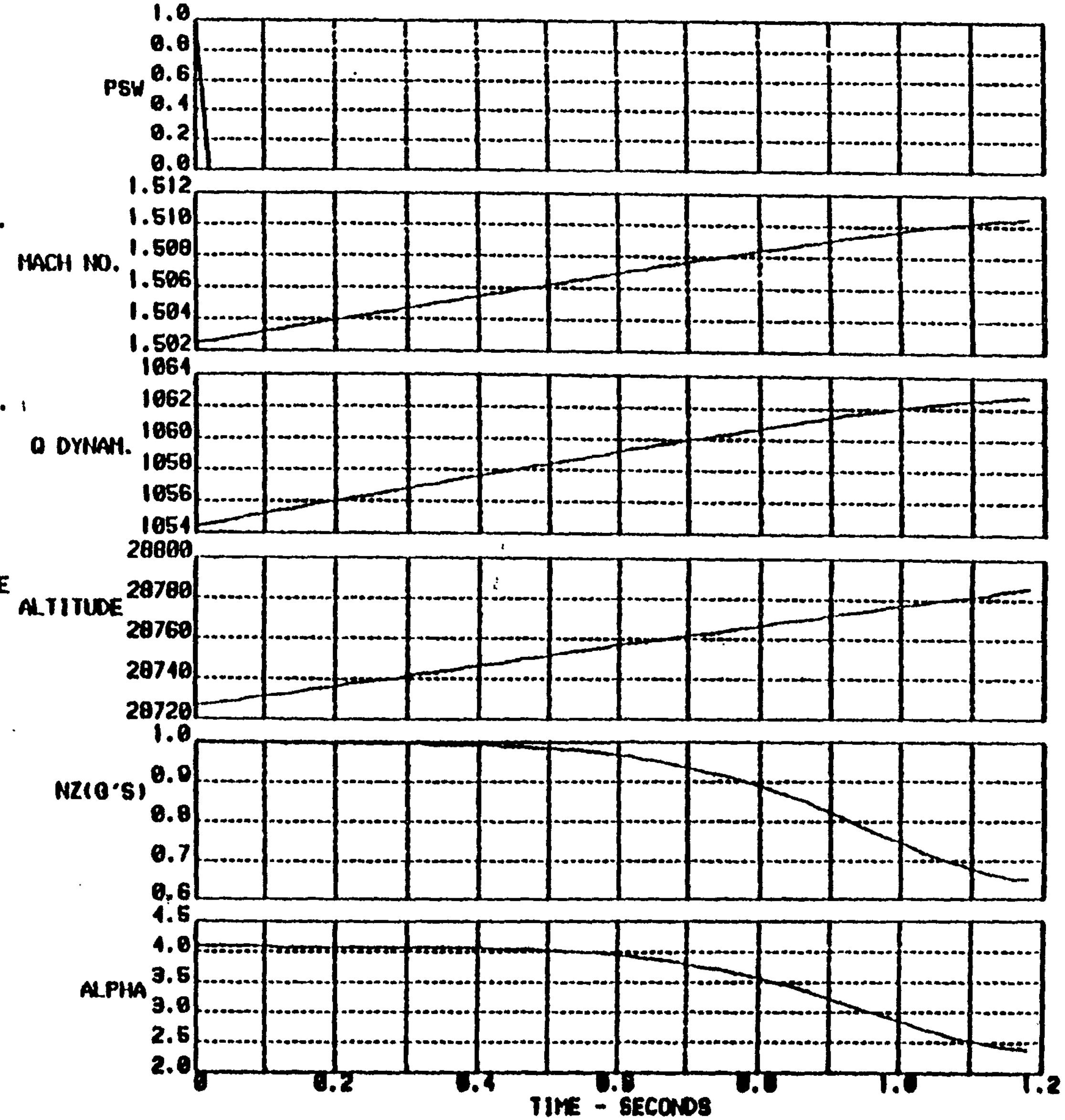
	TIME	Q DYNAM.
START	0.0000	1054.47
FINAL	1.1800	1062.88
MINIMUM	0.0000	1054.47
MAXIMUM	1.1800	1062.88

	TIME	ALTITUDE
START	0.0000	28726.50
FINAL	1.1800	28786.13
MINIMUM	0.0000	28726.50
MAXIMUM	1.1800	28786.13

	TIME	NZ(G'S)
START	0.0000	0.994
FINAL	1.1800	0.648
MINIMUM	1.1800	0.648
MAXIMUM	0.0000	0.994

	TIME	ALPHA
START	0.0000	4.102
FINAL	1.1800	2.395
MINIMUM	1.1800	2.395
MAXIMUM	0.0000	4.102

POWERED, CREW ESCAPE
WILL STOP AT AT=NZ +2.5,-1 NY +1,-1



	TIME	PB
START	0.0000	0.00
FINAL	1.1000	-12.35
MINIMUM	1.1000	-12.35
MAXIMUM	0.7800	42.50

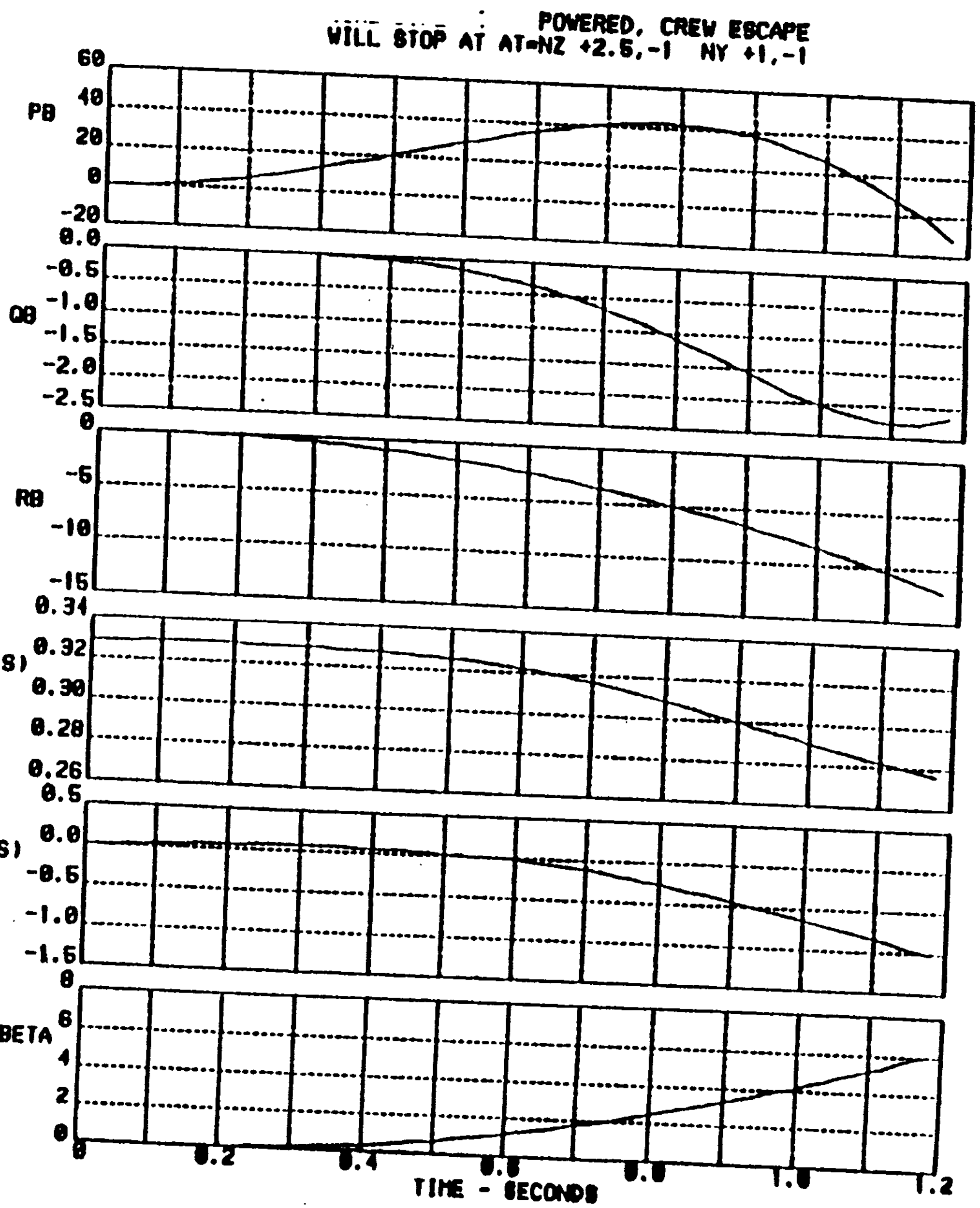
	TIME	QB
START	0.0000	0.000
FINAL	1.1000	-2.196
MINIMUM	1.1200	-2.280
MAXIMUM	0.0200	0.000

	TIME	RB
START	0.0000	0.00
FINAL	1.1000	-12.37
MINIMUM	1.1000	-12.37
MAXIMUM	0.0200	0.00

	TIME	NX(G'S)
START	0.0000	0.3286
FINAL	1.1000	0.2756
MINIMUM	1.1000	0.2756
MAXIMUM	0.1400	0.3289

	TIME	NY(G'S)
START	0.0000	0.000
FINAL	1.1000	-1.037
MINIMUM	1.1000	-1.037
MAXIMUM	0.3200	0.086

	TIME	BETA
START	0.0000	0.00
FINAL	1.1000	6.07
MINIMUM	0.0200	0.00
MAXIMUM	1.1000	6.07



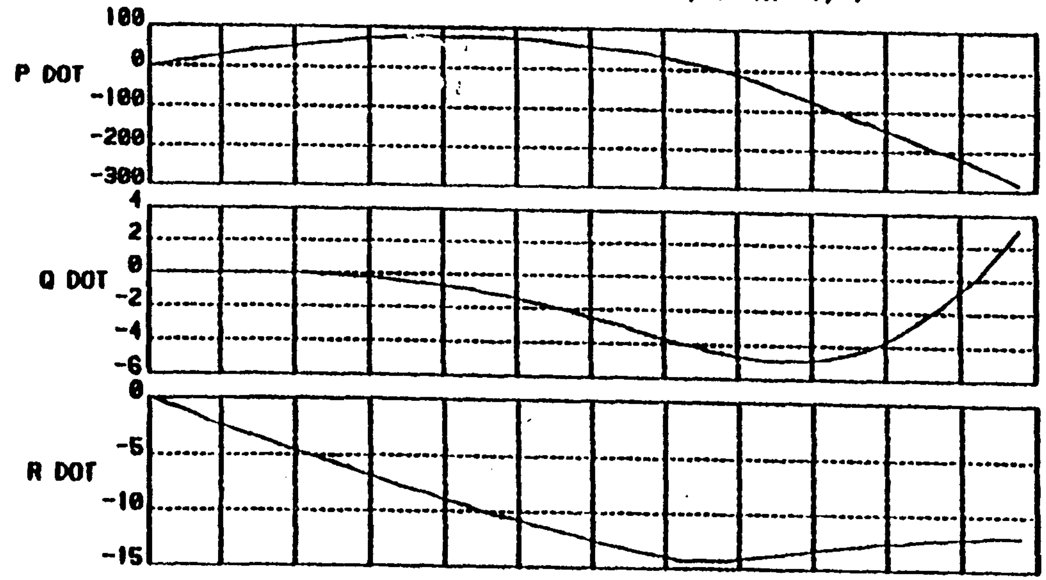
Mach 1.5

POWERED, CREW ESCAPE
WILL STOP AT AT=NZ +2.5,-1 NY +1,-1

	TIME	P DOT
START	0.0000	0.00
FINAL	1.1800	-285.47
MINIMUM	1.1800	-285.47
MAXIMUM	0.4200	70.17

	TIME	Q DOT
START	0.0000	0.00
FINAL	1.1800	3.16
MINIMUM	0.8600	-4.99
MAXIMUM	1.1800	3.16

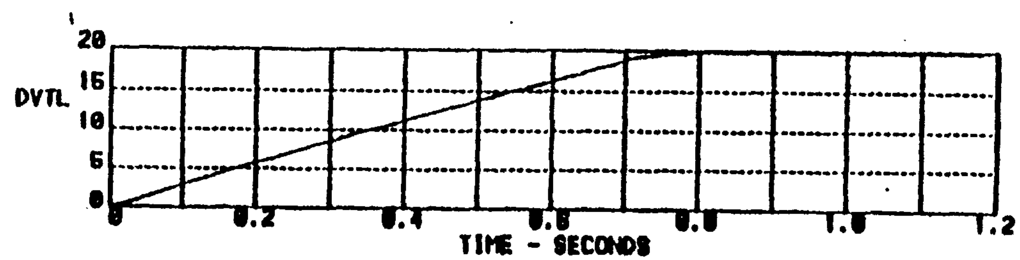
	TIME	R DOT
START	0.0000	0.00
FINAL	1.1800	-12.03
MINIMUM	0.7400	-14.34
MAXIMUM	0.0000	0.00



DTEO = -6.1794

DTAOP = 0

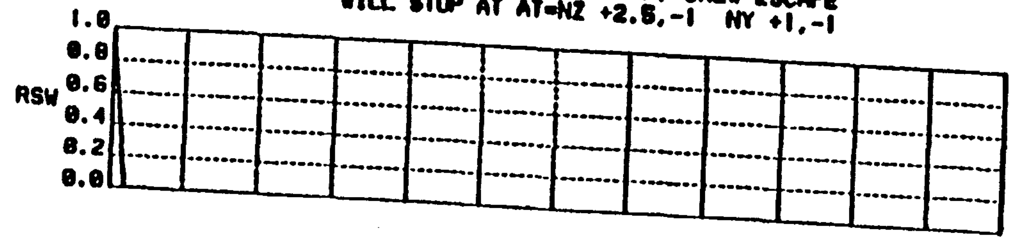
	TIME	DVTL
START	0.0000	0.00
FINAL	1.1800	20.00
MINIMUM	0.0000	0.00
MAXIMUM	1.1800	20.00



Mach 1.5

POWERED, CREW ESCAPE
WILL STOP AT AT=NZ +2.5,-1 NY +1,-1

	TIME	RSW
START	0.0000	1.000
FINAL	1.1000	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000



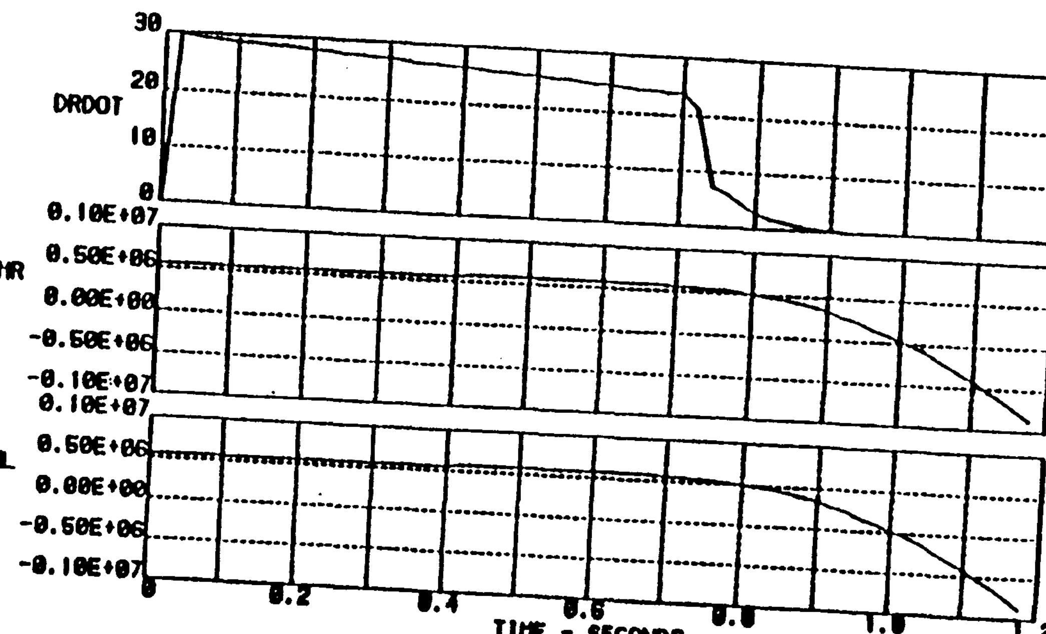
DEDOT = 0

DADOT = 0

	TIME	DRDOT
START	0.0000	0.00
FINAL	1.1000	0.00
MINIMUM	0.0000	0.00
MAXIMUM	0.0200	30.00

	TIME	HMR
START	0.0000	0.56965E+06
FINAL	1.1000	-.89148E+06
MINIMUM	1.1000	-.89148E+06
MAXIMUM	0.5800	0.59438E+06

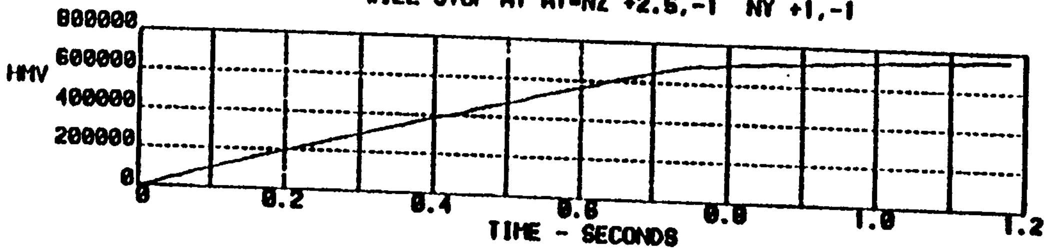
	TIME	HML
START	0.0000	0.56965E+06
FINAL	1.1000	-.89148E+06
MINIMUM	1.1000	-.89148E+06
MAXIMUM	0.5800	0.59438E+06



Mach 1.5

	TIME	HMV
START	0.0000	0.00
FINAL	1.1000	754706.62
MINIMUM	0.0000	0.00
MAXIMUM	1.1000	754706.62

POWERED, CREW ESCAPE
WILL STOP AT AT=NZ +2.5,-1 NY +1,-1



	TIME	PSW
START	0.0000	1.000
FINAL	2.5000	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000

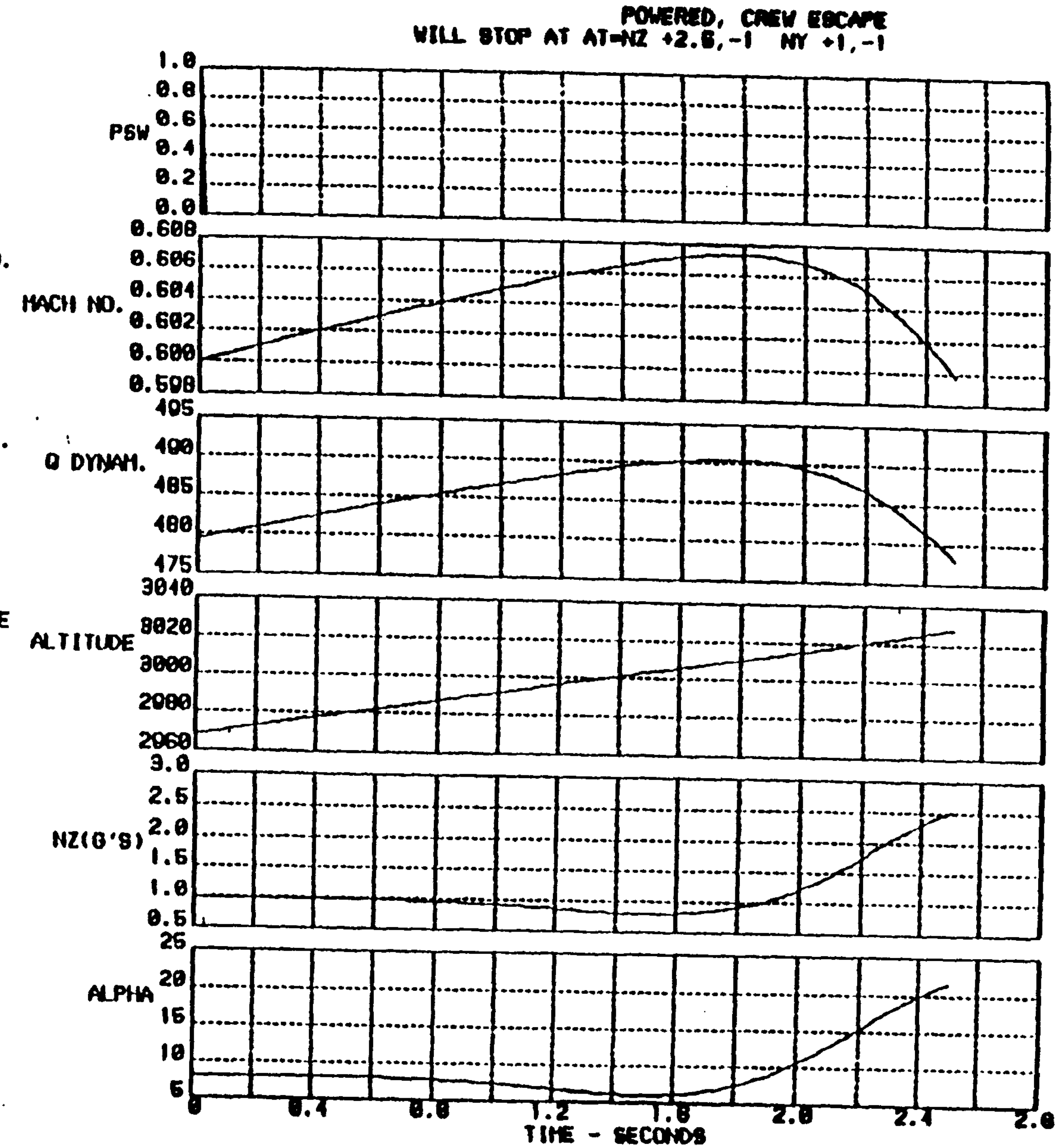
	TIME	MACH NO.
START	0.0000	0.60000
FINAL	2.5000	0.59982
MINIMUM	2.5000	0.59982
MAXIMUM	1.7600	0.60737

	TIME	Q DYNAM.
START	0.0000	479.43
FINAL	2.5000	478.07
MINIMUM	2.5000	478.07
MAXIMUM	1.7600	490.53

	TIME	ALTITUDE
START	0.0000	2968.44
FINAL	2.5000	3028.76
MINIMUM	0.0000	2968.44
MAXIMUM	2.5000	3028.76

	TIME	NZ(G'S)
START	0.0000	0.984
FINAL	2.5000	2.534
MINIMUM	1.5000	0.810
MAXIMUM	2.5000	2.534

	TIME	ALPHA
START	0.0000	8.14
FINAL	2.5000	21.78
MINIMUM	1.5000	6.15
MAXIMUM	2.5000	21.78



	TIME	PB
START	0.0000	0.00
FINAL	2.5000	-104.09
MINIMUN	2.2800	-116.18
MAXIMUM	0.9000	30.41

	TIME	QB
START	0.0000	0.00
FINAL	2.5000	16.09
MINIMUN	1.4400	-1.87
MAXIMUM	2.5000	16.09

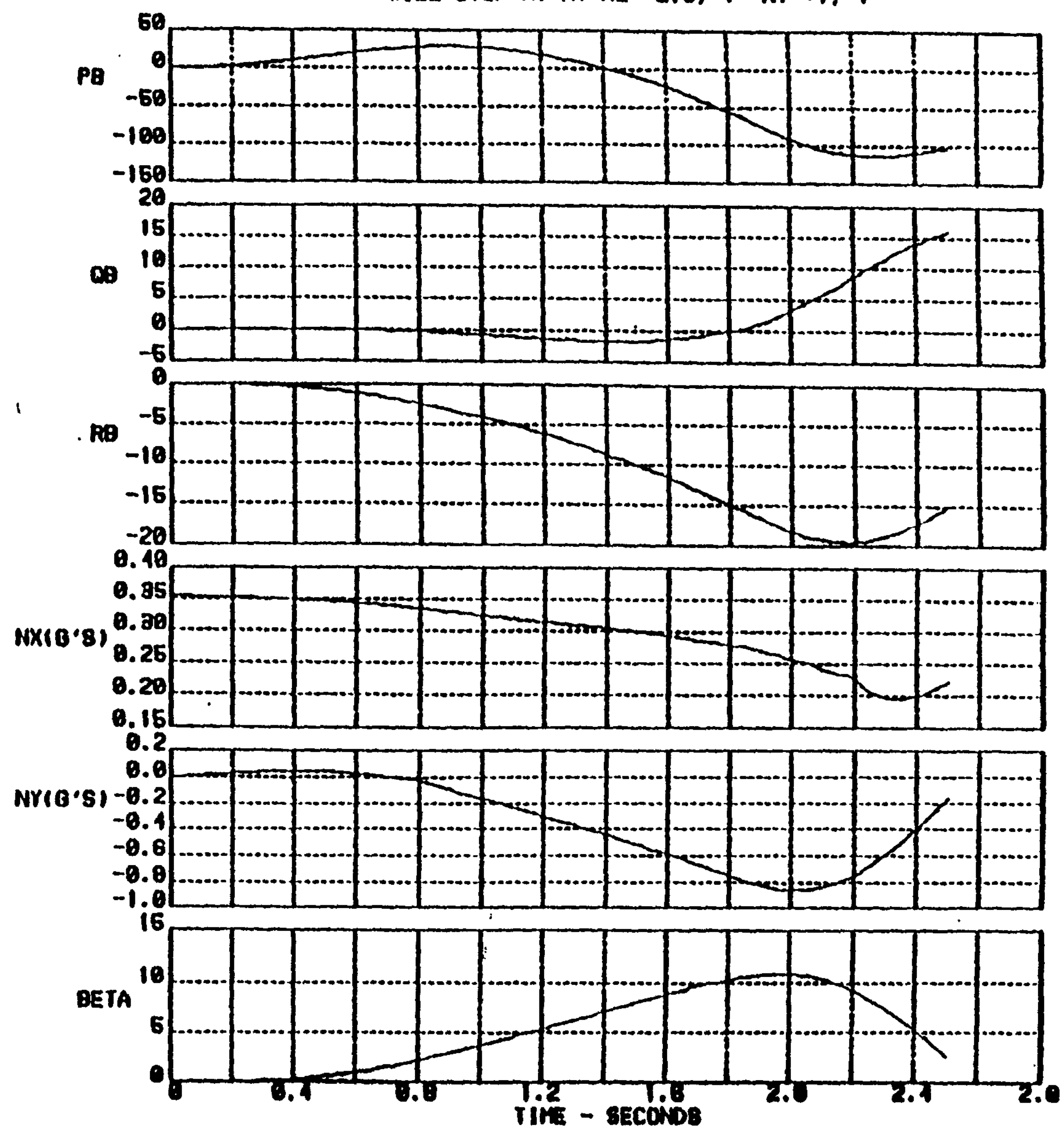
	TIME	RB
START	0.0000	0.00
FINAL	2.5000	-15.19
MINIMUN	2.1800	-19.60
MAXIMUM	0.0000	0.00

	TIME	NX(G'S)
START	0.0000	0.3530
FINAL	2.5000	0.2216
MINIMUN	2.3400	0.1934
MAXIMUM	0.0000	0.3530

	TIME	NY(G'S)
START	0.0000	0.000
FINAL	2.5000	-0.160
MINIMUN	2.0200	-0.876
MAXIMUM	0.4000	0.054

	TIME	BETA
START	0.0000	0.00
FINAL	2.6000	2.64
MINIMUN	0.0200	0.00
MAXIMUM	1.0600	10.80

POWERED, CREW ESCAPE
WILL STOP AT AT=NZ +2.5,-1 NY +1,-1



Mach 0.6

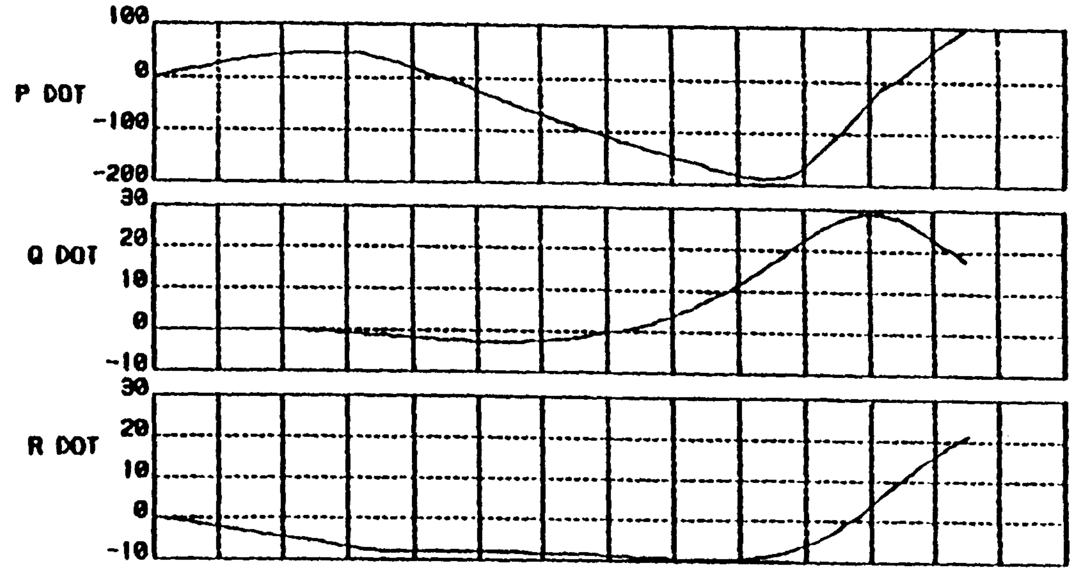
Mach 0.6

POWERED, CREW ESCAPE
WILL STOP AT AT=NZ +2.5,-1 NY +1,-1

	TIME	P DOT
START	0.0000	0.00
FINAL	2.5000	99.20
MINIMUM	1.8800	-186.68
MAXIMUM	2.5000	99.20

	TIME	Q DOT
START	0.0000	0.00
FINAL	2.5000	17.91
MINIMUM	1.0600	-2.04
MAXIMUM	2.2200	29.03

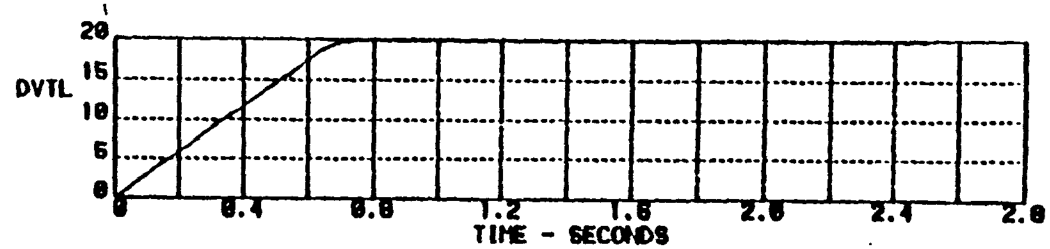
	TIME	R DOT
START	0.0000	0.00
FINAL	2.5000	21.31
MINIMUM	1.7000	-9.07
MAXIMUM	2.5000	21.91



DTEO = 0.92481

DTAOP = 0

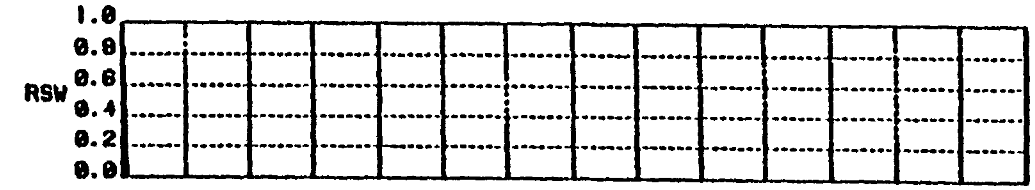
	TIME	DVTL
START	0.0000	0.00
FINAL	2.5000	20.00
MINIMUM	0.0000	0.00
MAXIMUM	1.2800	20.00



Mach 0.6

POWERED, CREW ESCAPE
WILL STOP AT AT=NZ +2.5,-1 NY +1,-1

	TIME	RSW
START	0.0000	1.000
FINAL	2.5000	0.000
MINIMUM	0.0200	0.000
MAXIMUM	0.0000	1.000



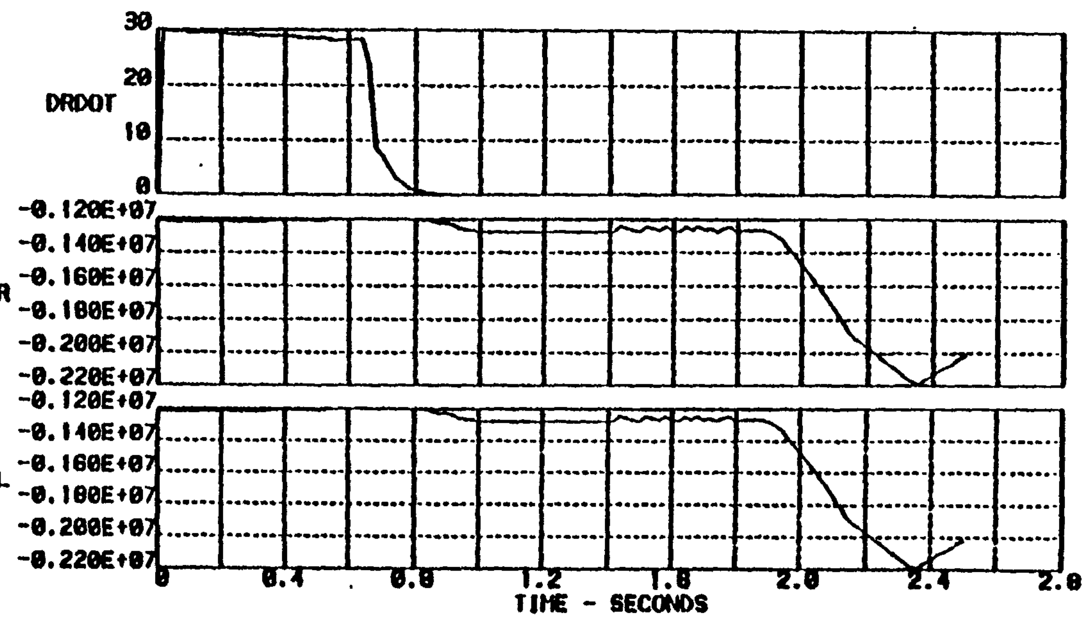
DEDOT = 0

DADOT = 0

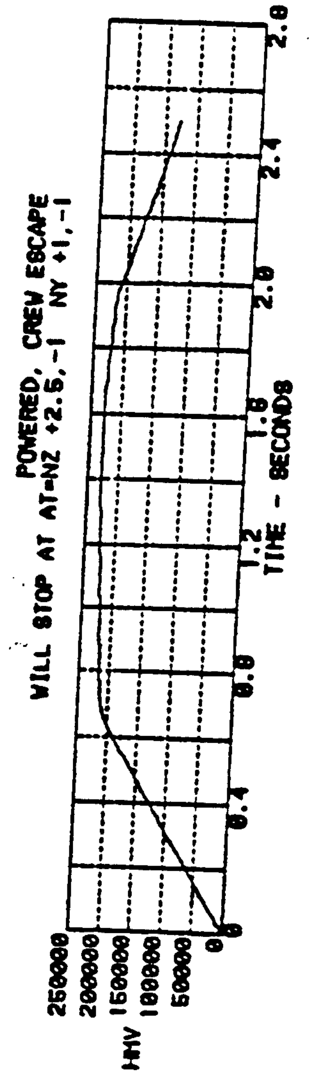
	TIME	DRDOT
START	0.0000	0.00
FINAL	2.5000	0.00
MINIMUM	1.3000	0.00
MAXIMUM	0.0200	30.00

	TIME	HMR
START	0.0000	-.12207E+07
FINAL	2.5000	-.20290E+07
MINIMUM	2.3600	-.21051E+07
MAXIMUM	0.6800	-.12029E+07

	TIME	HML
START	0.0000	-.12207E+07
FINAL	2.5000	-.20290E+07
MINIMUM	2.3600	-.21051E+07
MAXIMUM	0.6800	-.12029E+07



Mach 0.6



	TIME	HMV
START	0.0000	0.00
FINAL	2.5000	128706.17
MINIMUM	0.0000	0.00
MAXIMUM	1.5200	220498.87

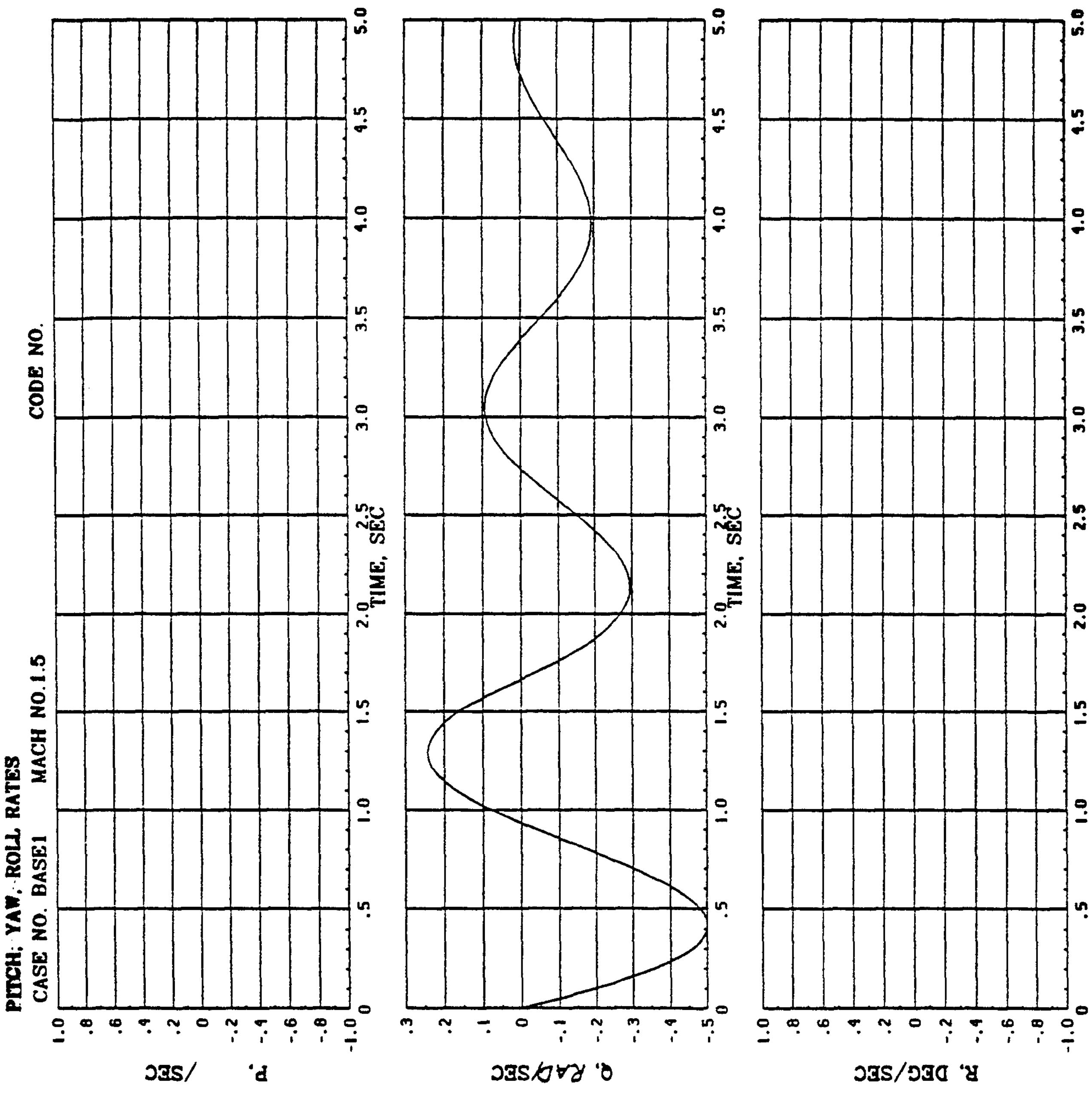
APPENDIX D

Separation Dynamics Analysis
Output Plots for Cases 1 - 18

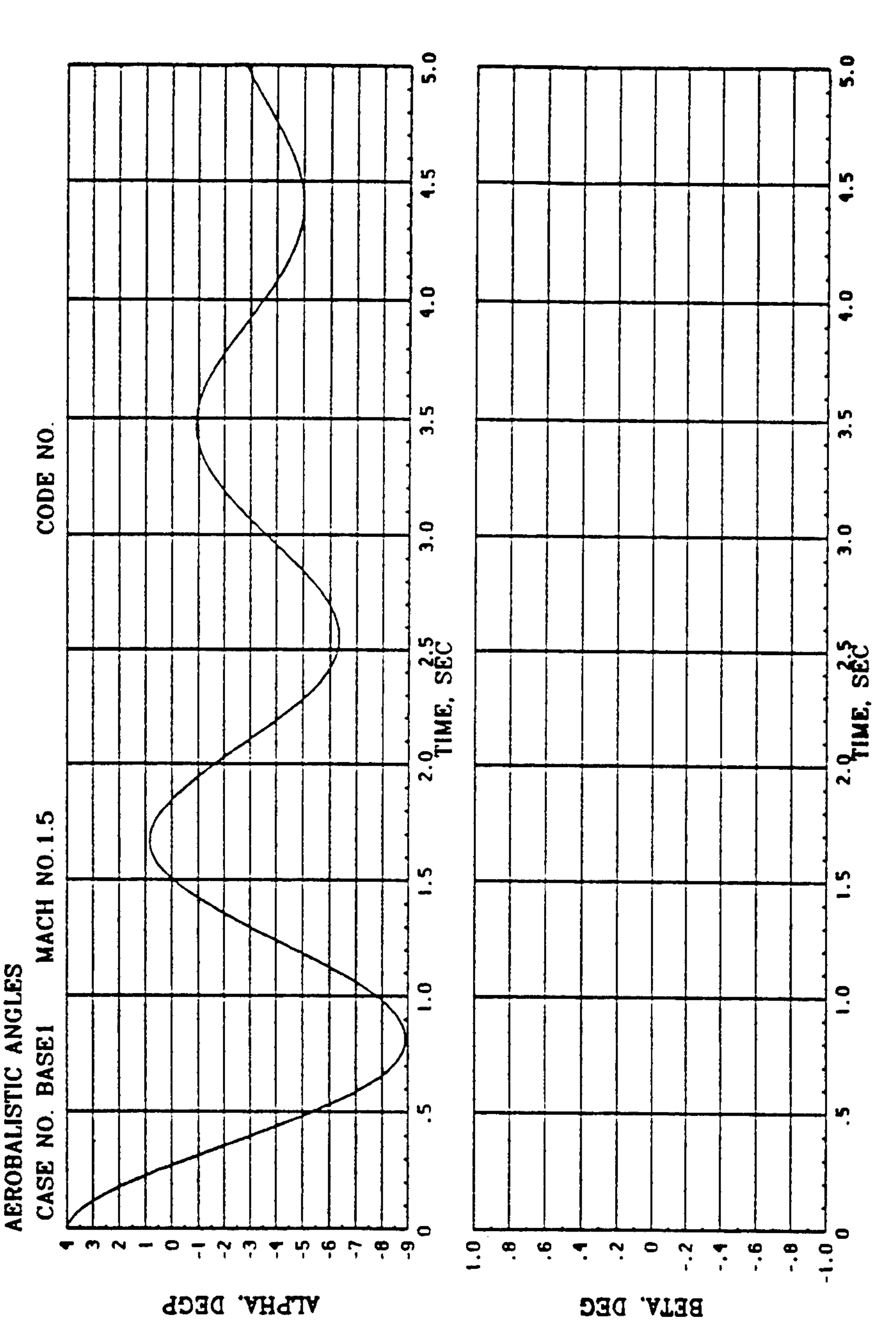
This appendix contains the plotted output for the separation dynamics analysis performed under Task III. The plotted results are presented case-by-case according to the matrix below. Information regarding these results is found in Task III of this report.

External Influences	Mach 1.5 Initial conditions		Mach 6.0 Initial conditions		Mach 20.0 Initial conditions	
	Nominal	Adverse	Nominal	Adverse	Nominal	Adverse
Free Flight	Case 1	Case 4	Case 7	Case 10	Case 13	Case 16
Aftbody Interference Aerodynamics	Case 2	Case 5	Case 8	Case 11	Case 14	Case 17
Aftbody Interference Aerodynamics + Blast Wave	Case 3	Case 6	Case 9	Case 12	Case 15	Case 18

Case 1

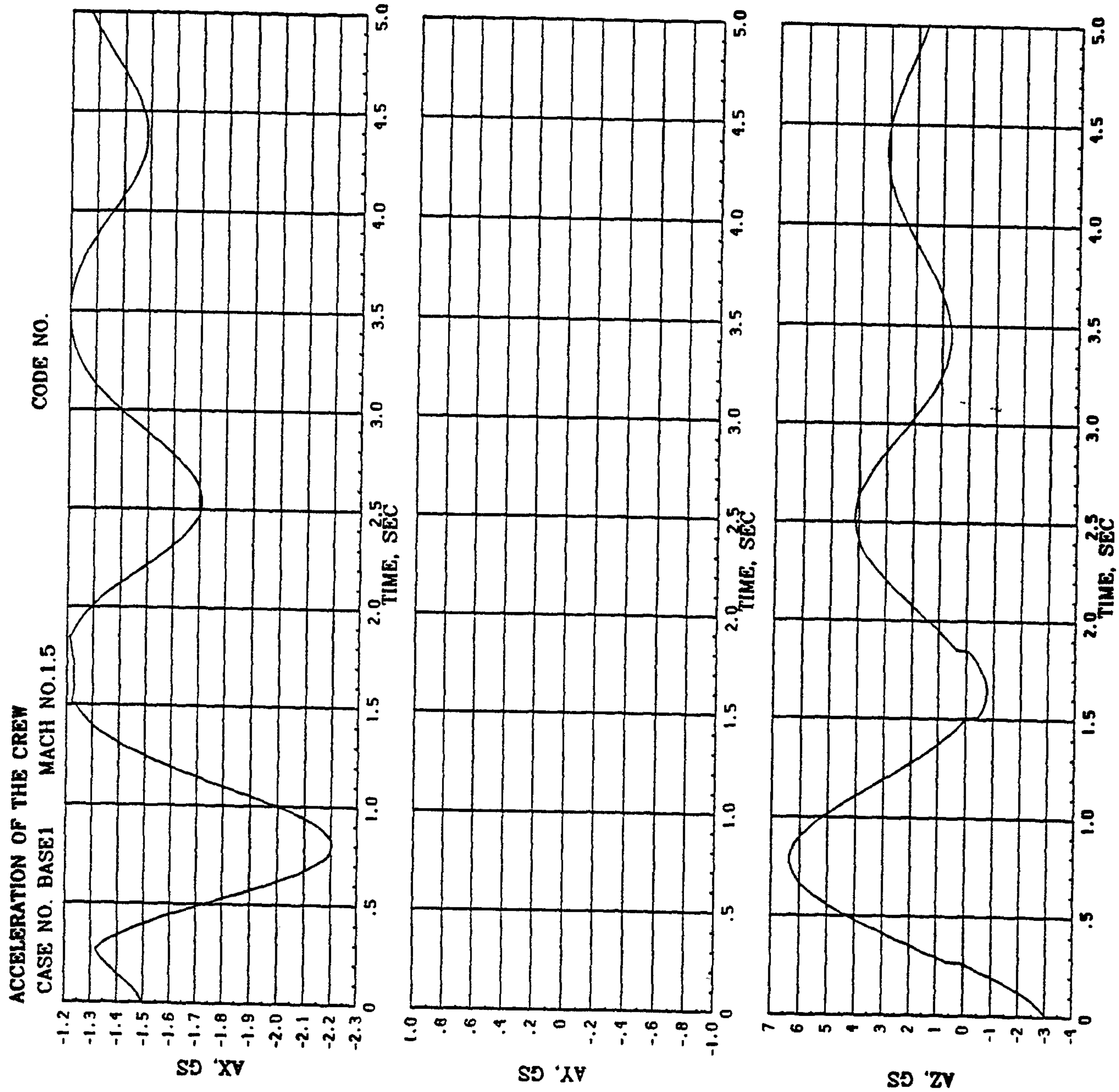

PITCH, YAW, ROLL RATES
CASE NO. BASE1
MACH NO.1.5
CODE NO.
P, /SEC
Q, RAD/SEC
R, DEG/SEC
TIME, SEC
TIME, SEC
TIME, SEC
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
1.0
.8
.6
.4
.2
0
-.2
-.4
-.6
-.8
-1.0
.3
.2
.1
0
-.1
-.2
-.3
-.4
-.5

Case 1



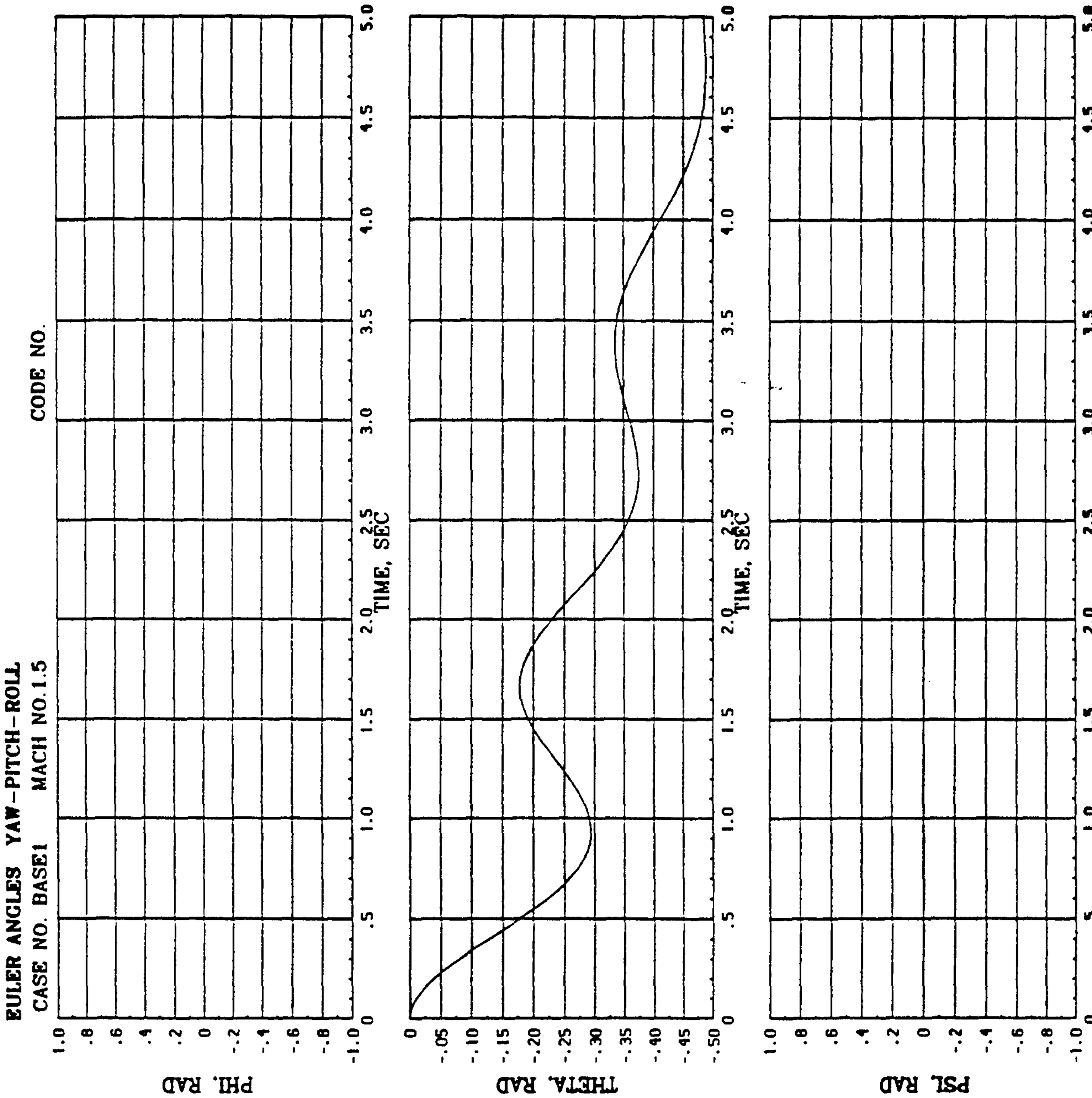
AEROBALISTIC ANGLES
CASE NO. BASE1
MACH NO. 1.5
CODE NO.
ALPHA, DEGP
BETA, DEG
TIME, SEC
TIME, SEC

Case 1

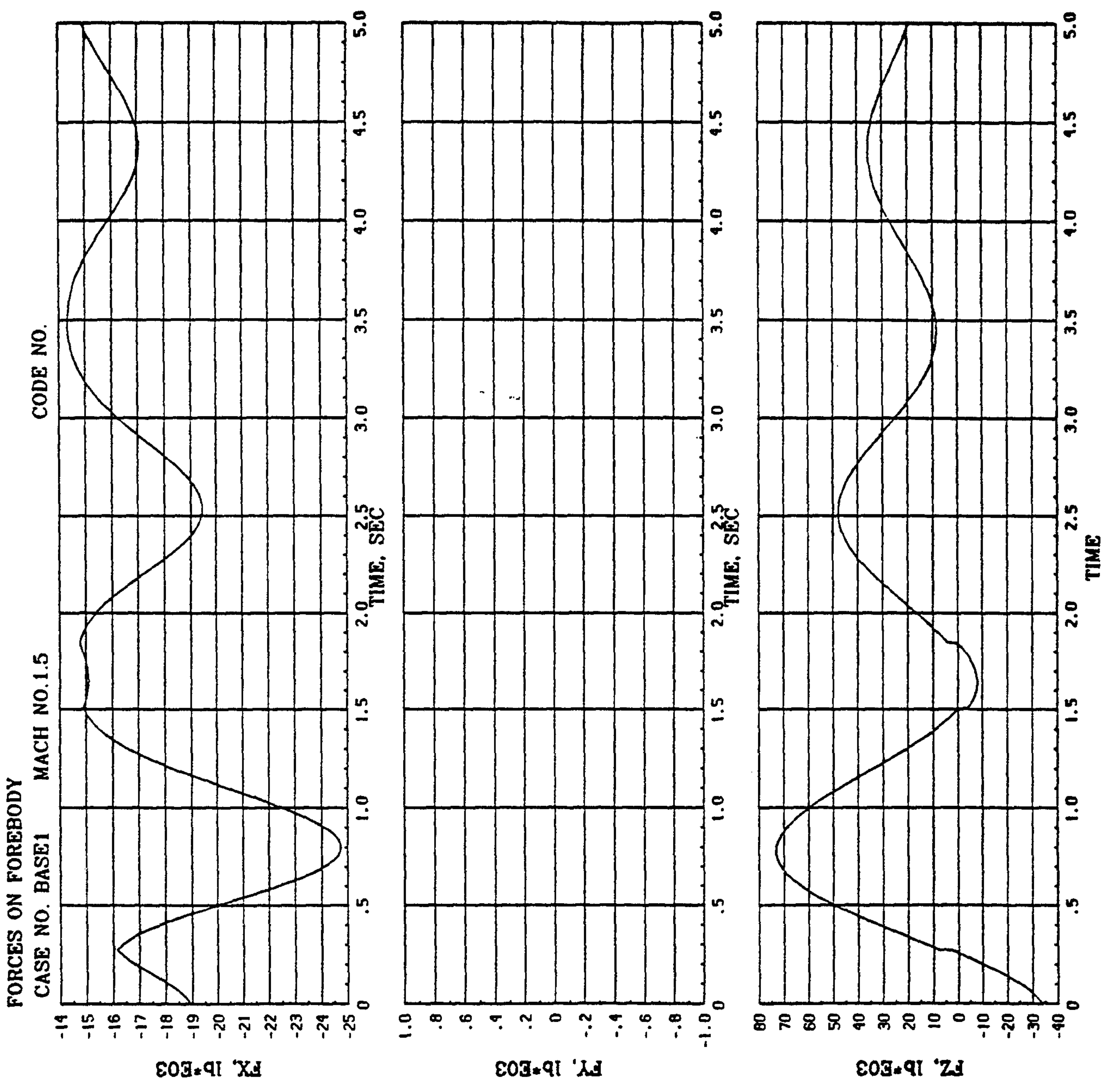


ACCELERATION OF THE CREW
CASE NO. BASE1
MACH NO.1.5
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 1

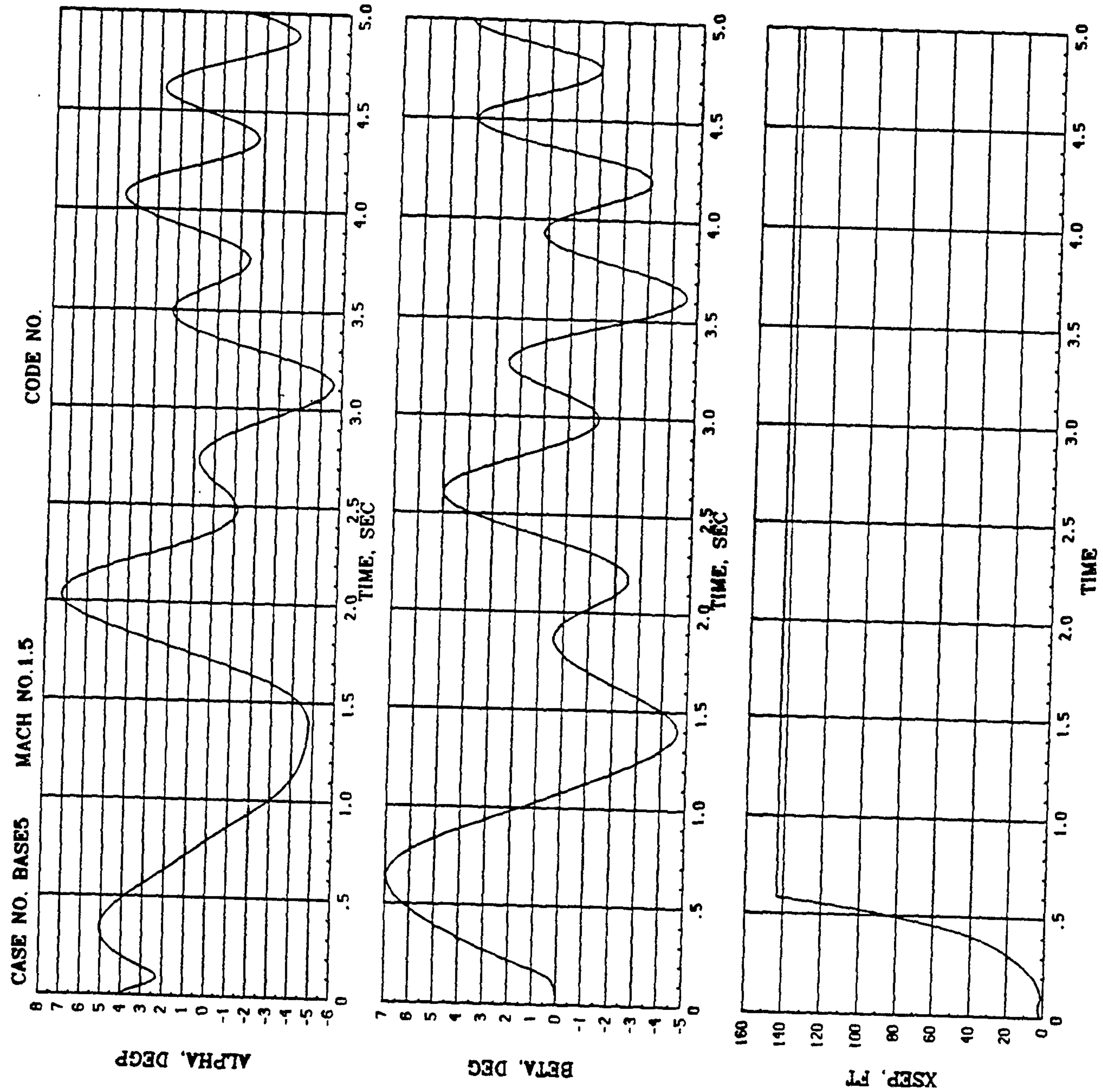

EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE1
MACH NO.1.5
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
TIME, SEC
TIME, SEC

Case 1

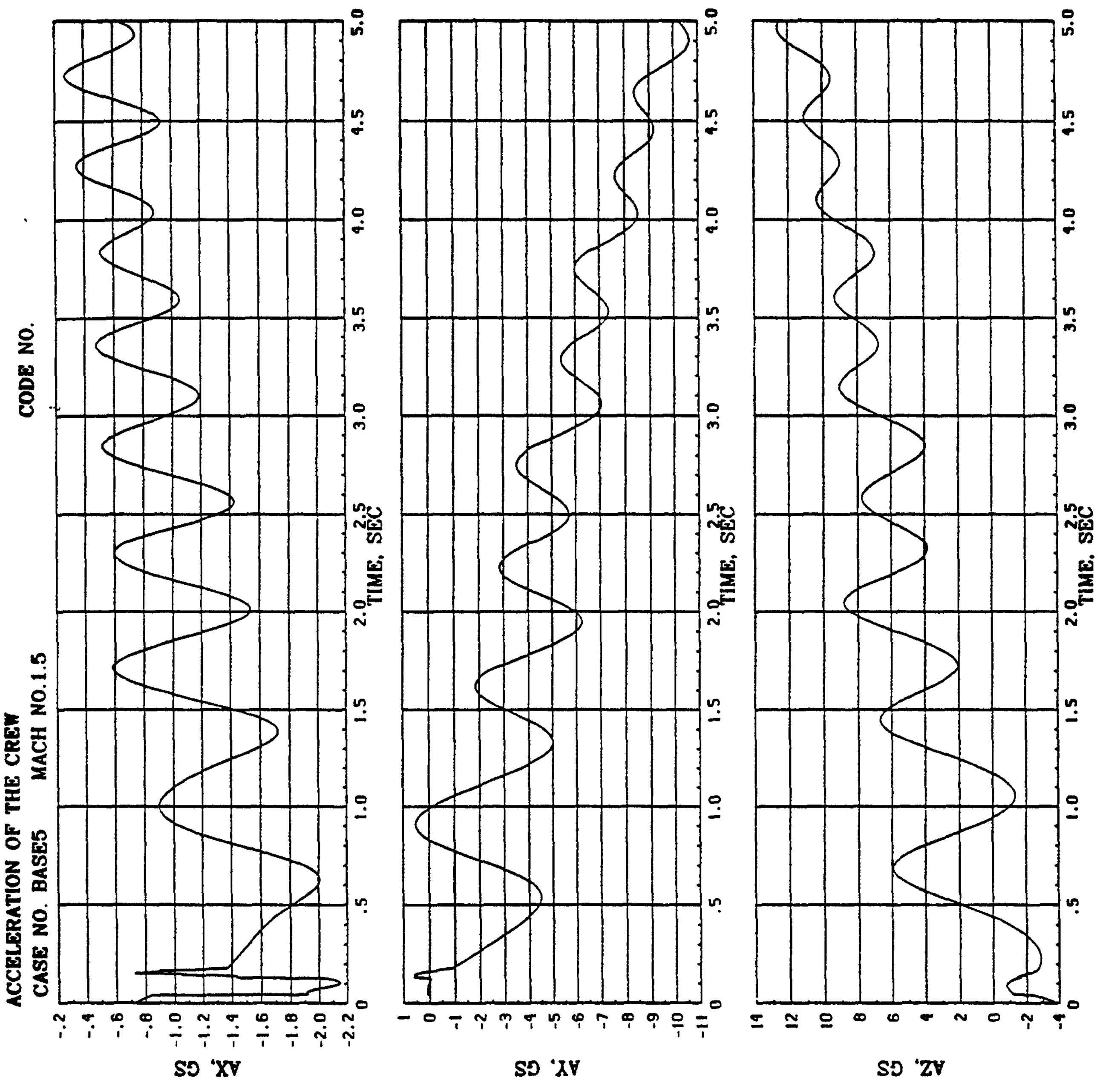


FORCES ON FOREBODY
CASE NO. BASE1
MACH NO.1.5
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

Case 2

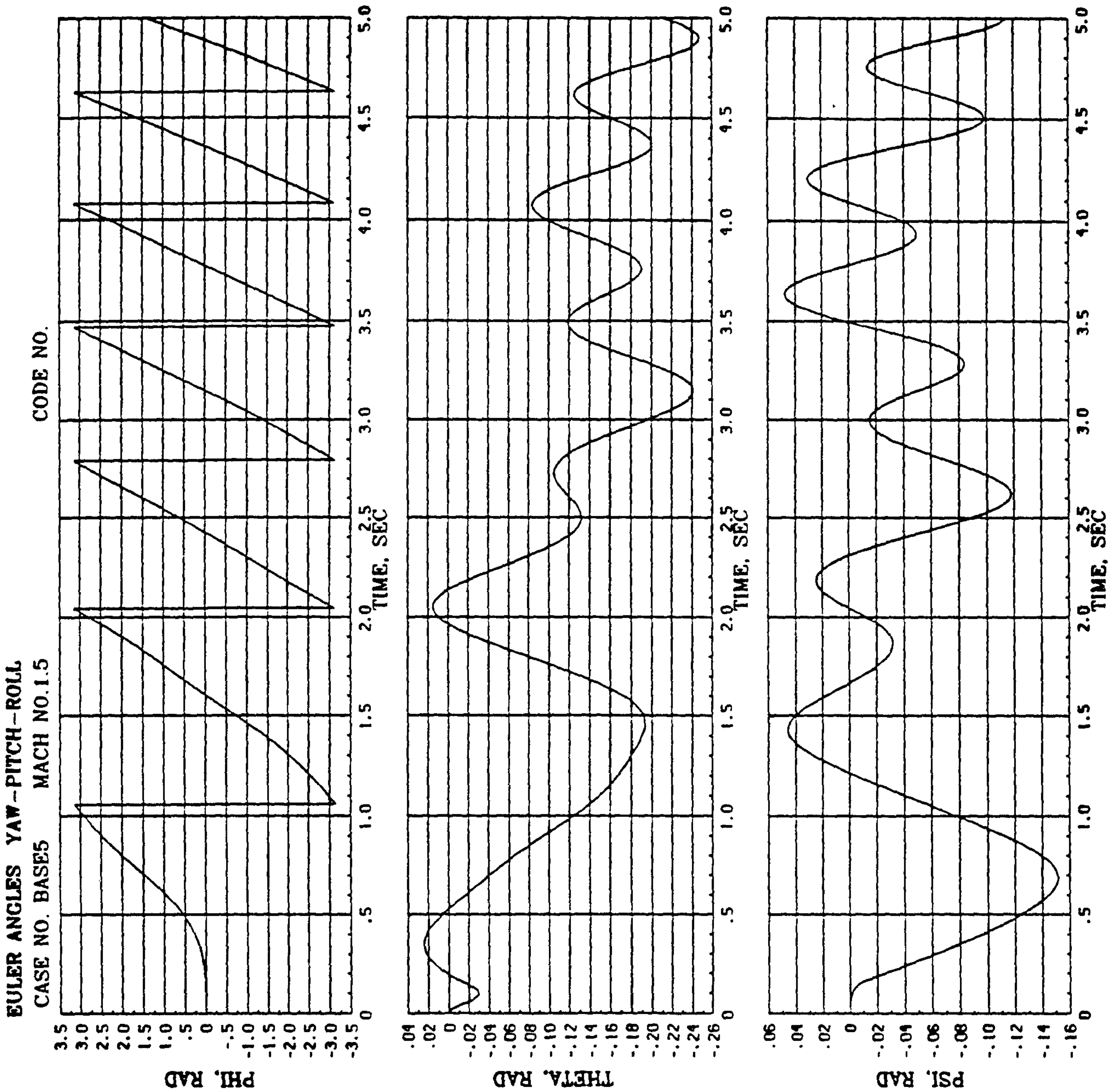

CASE NO. BASE5
MACH NO.1.5
CODE NO.
ALPHA, DEGP
BETA, DEG
XSEP, FT
TIME, SEC
TIME, SEC
TIME

Case 2

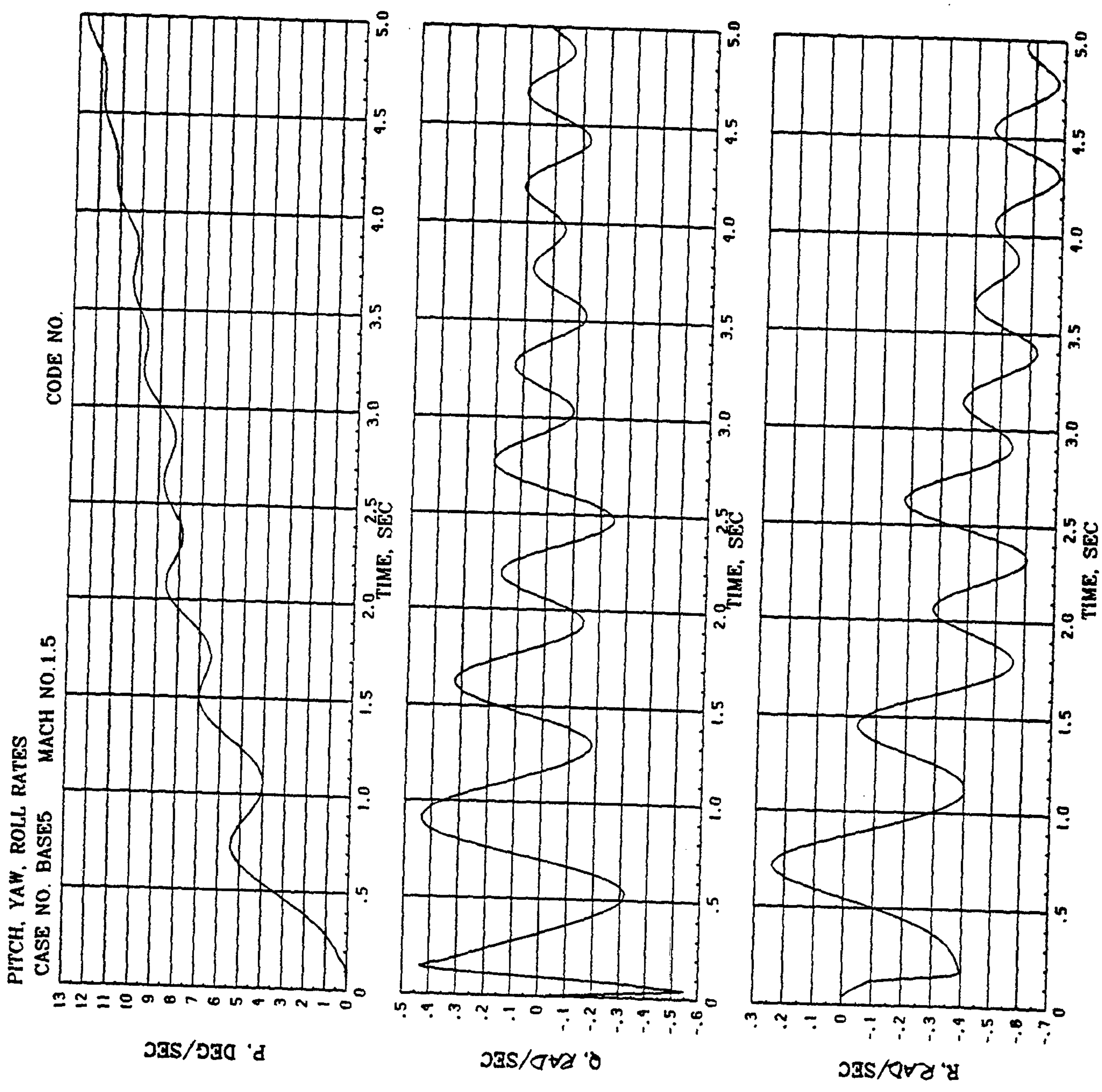


ACCELERATION OF THE CREW
CASE NO. BASE5 MACH NO.1.5
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
TIME, SEC
TIME, SEC

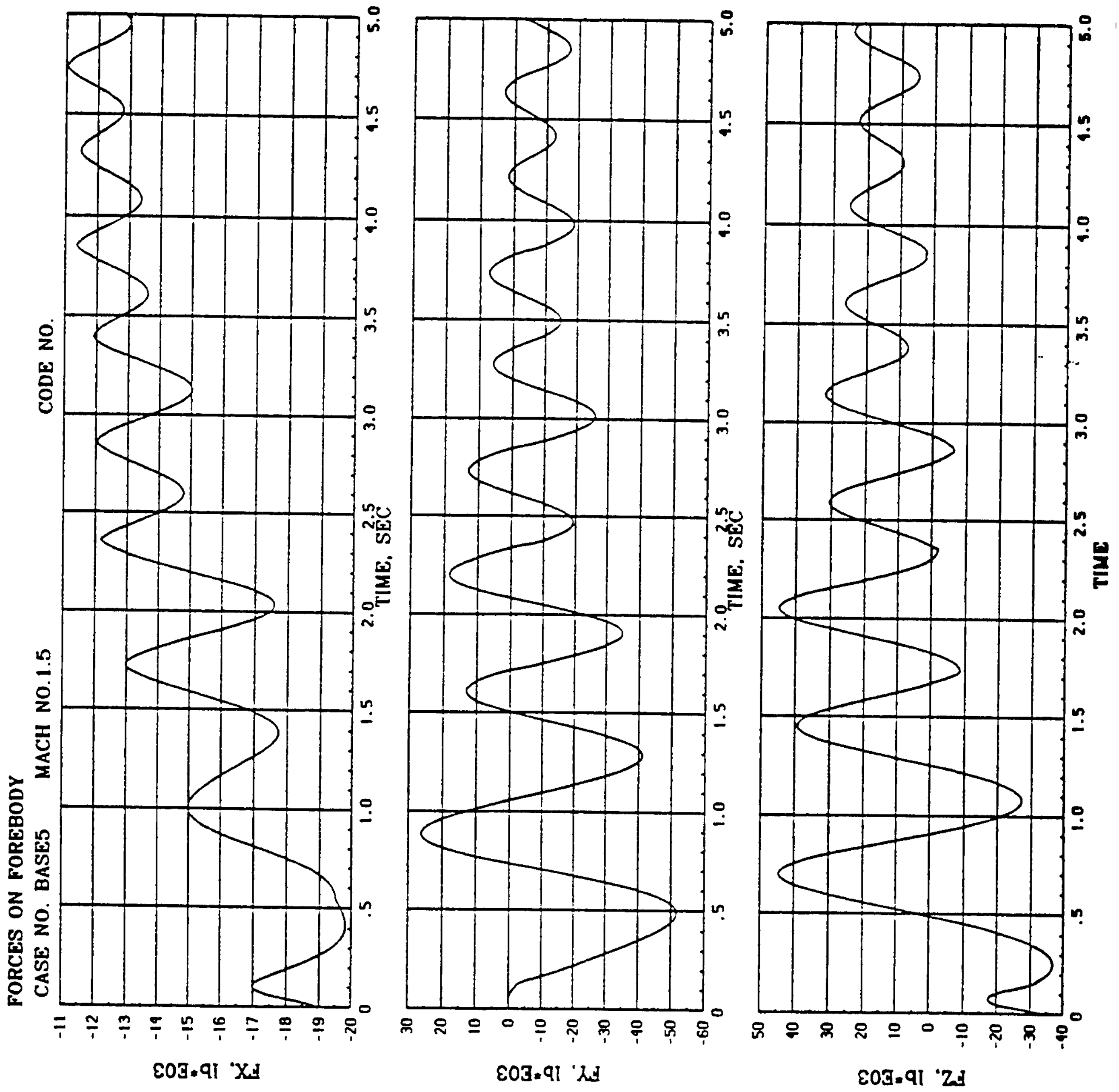
Case 2


EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE5
MACH NO.1.5
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
TIME, SEC
TIME, SEC

Case 2

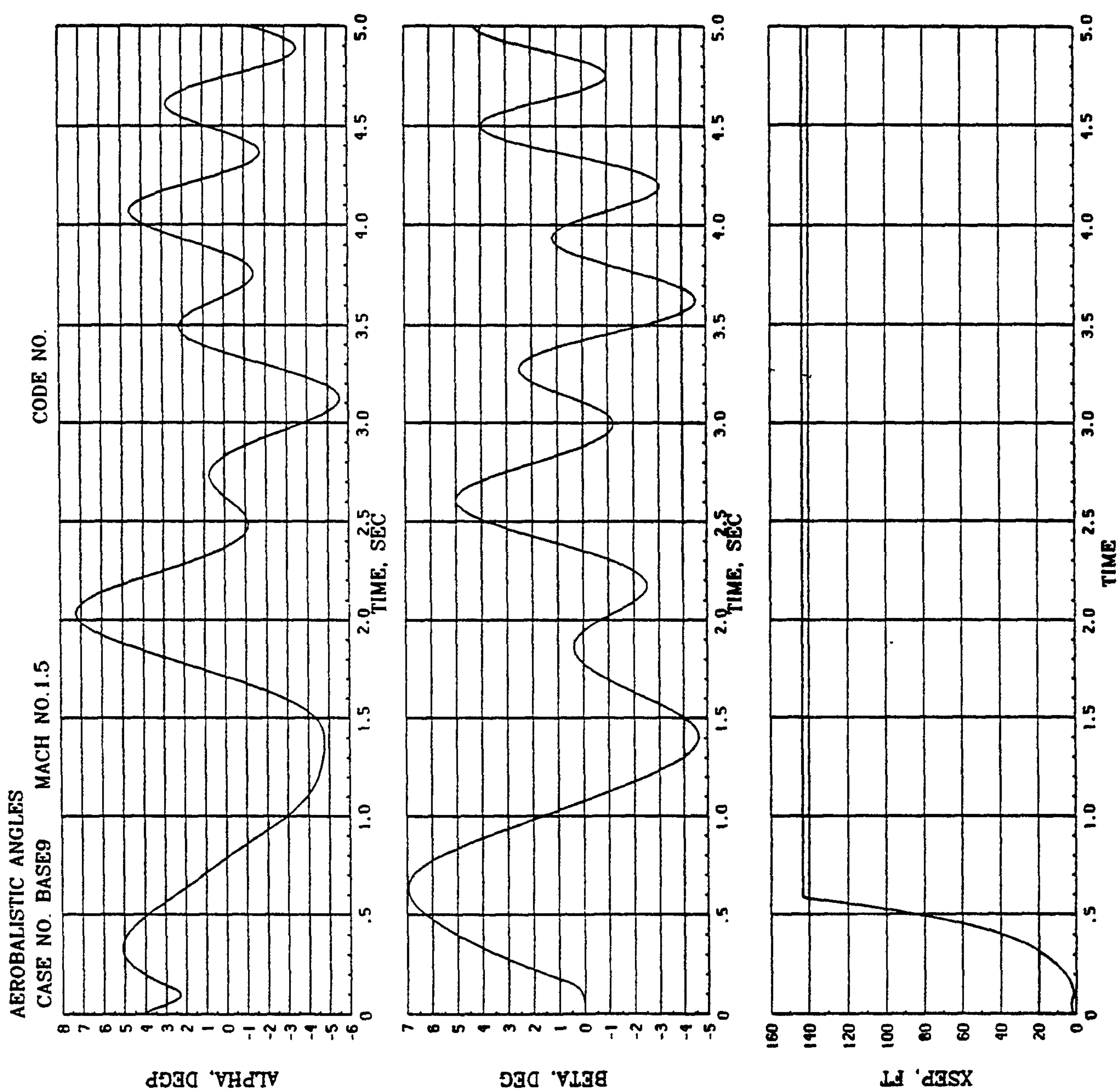

PITCH, YAW, ROLL RATES
CASE NO. BASE5
MACH NO.1.5
CODE NO.
TIME, SEC
P, DEG/SEC
Q, RAD/SEC
R, RAD/SEC

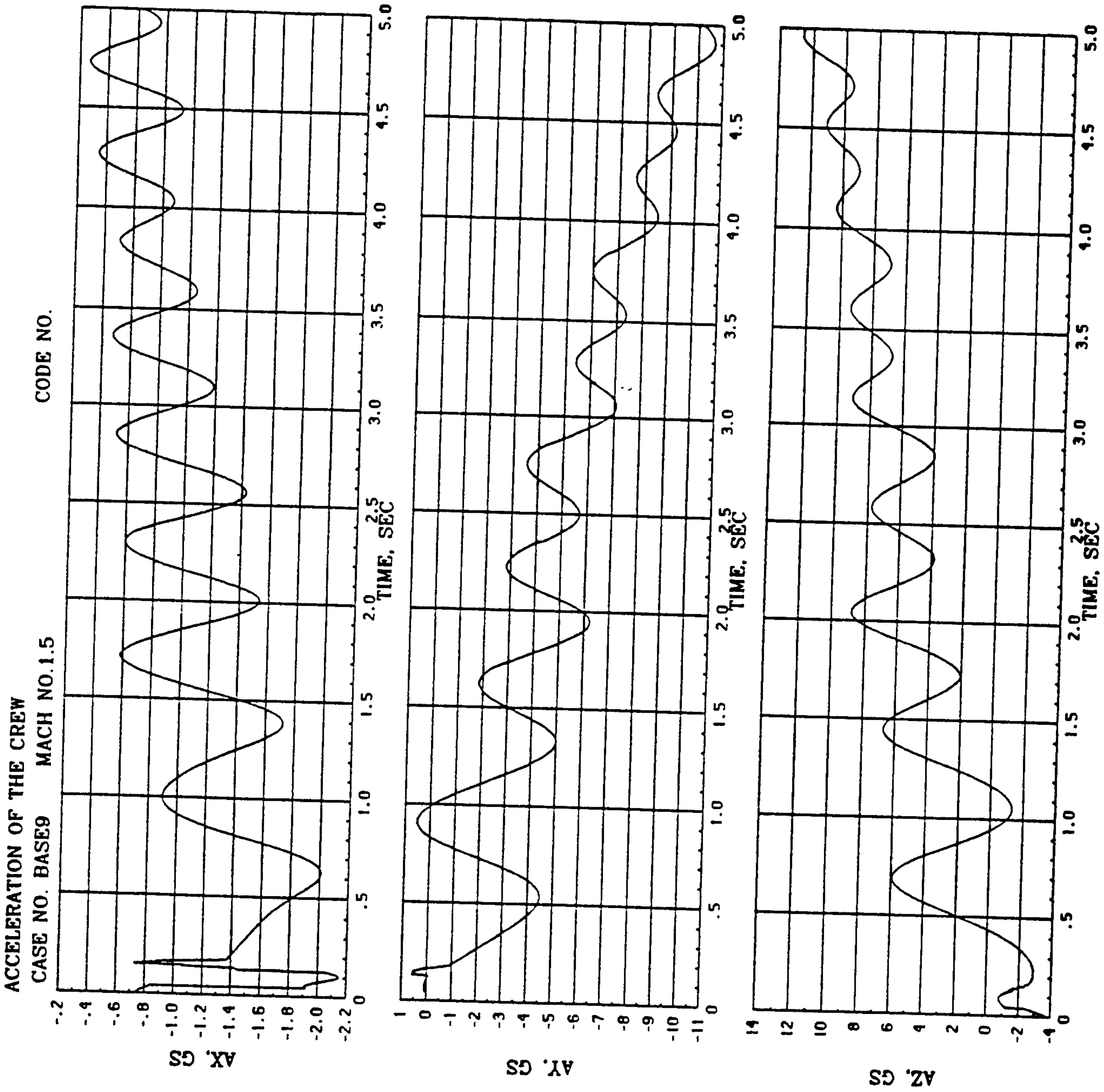
Case 2



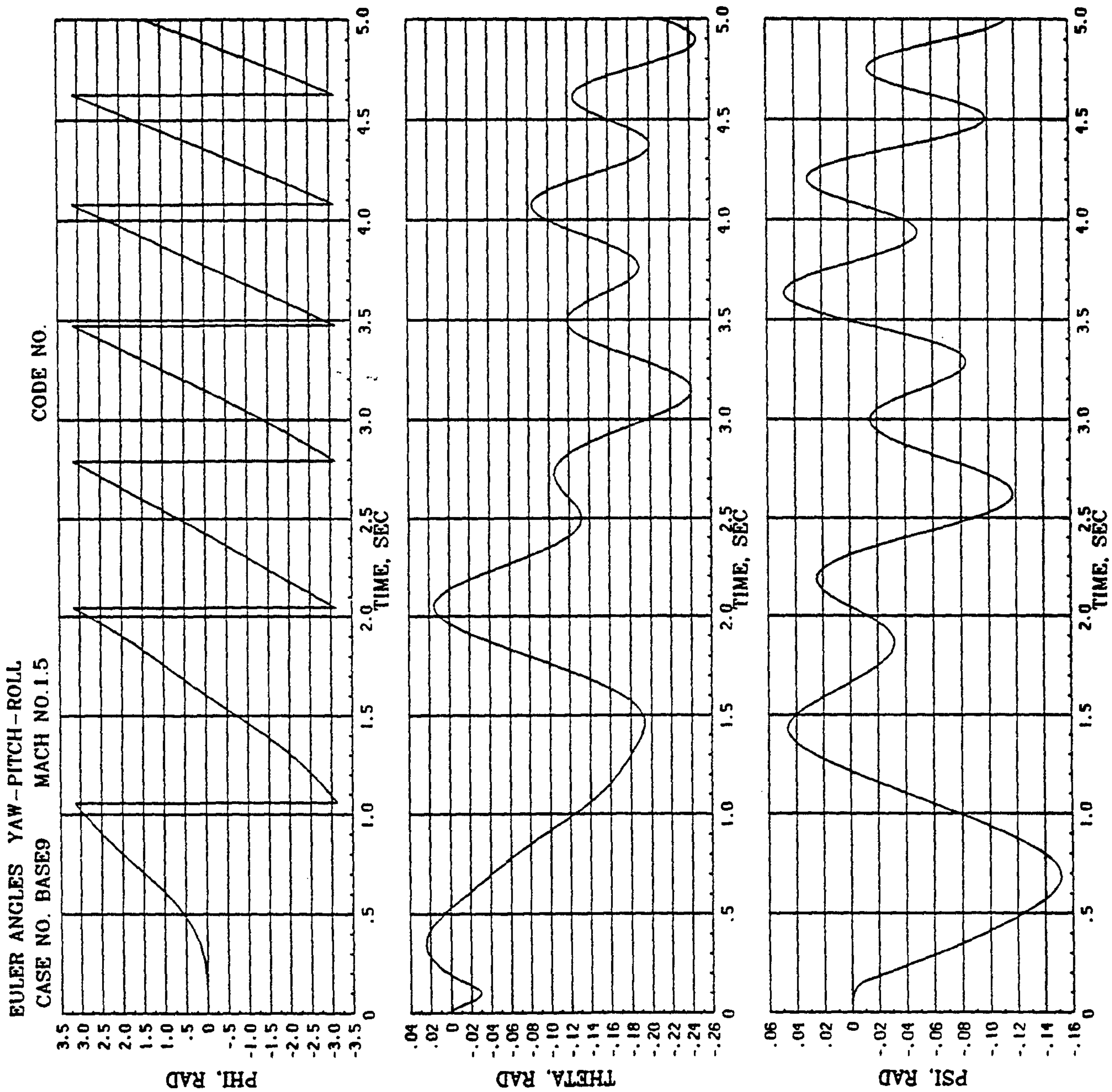
FORCES ON FOREBODY
CASE NO. BASE5
MACH NO.1.5
CODE NO.
TIME, SEC
TIME, SEC
TIME
FX, lb*E03
FY, lb*E03
FZ, lb*E03

Case 3

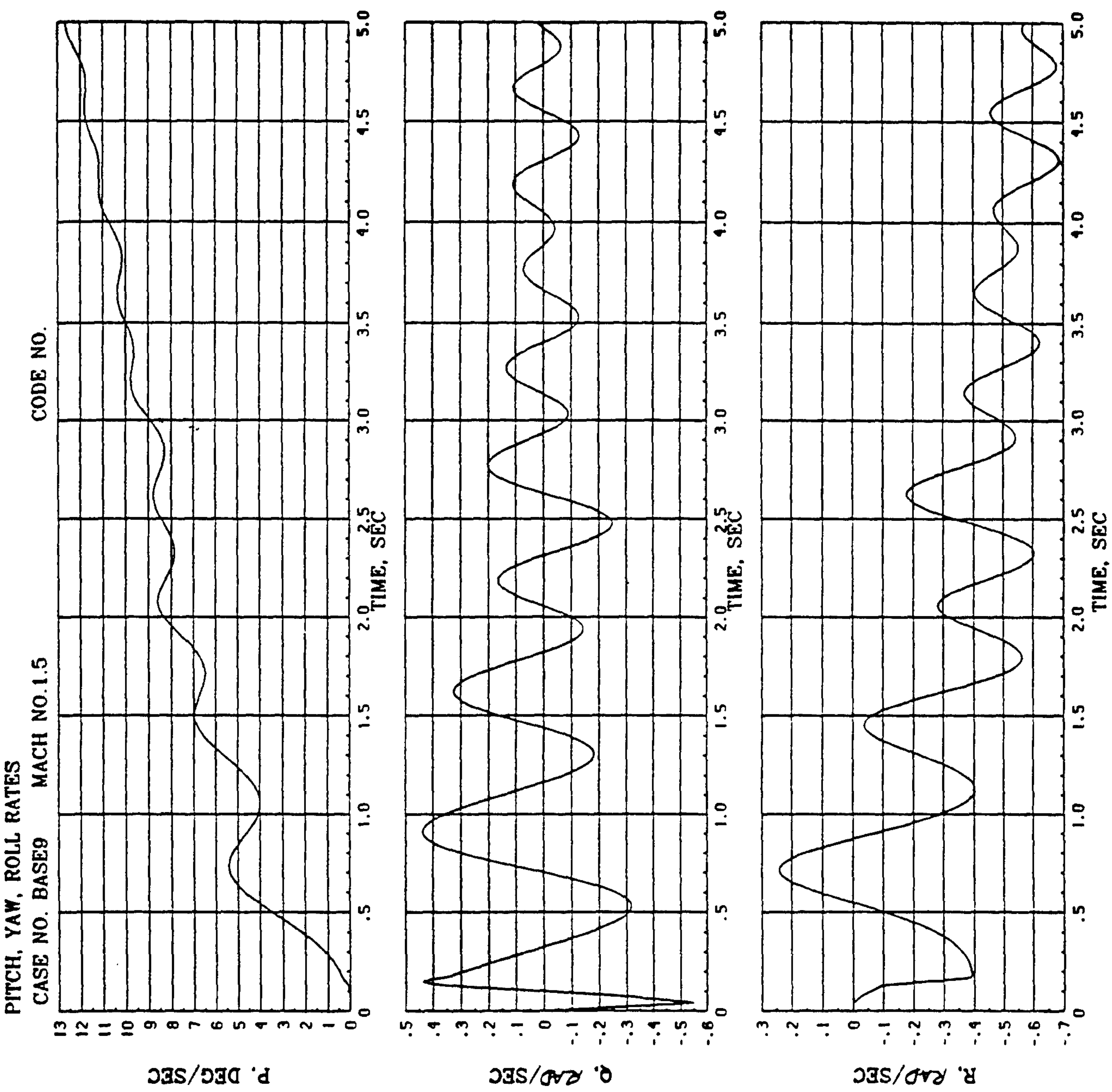

AEROBALISTIC ANGLES
CASE NO. BASE9
MACH NO.1.5
CODE NO.
ALPHA, DEGP
BETA, DEG
XSEP, FT
TIME, SEC
TIME, SEC
TIME


ACCELERATION OF THE CREW
CASE NO. BASE9
MACH NO.1.5
CODE NO.
TIME, SEC
AX, GS
AY, GS
AZ, GS

Case 3

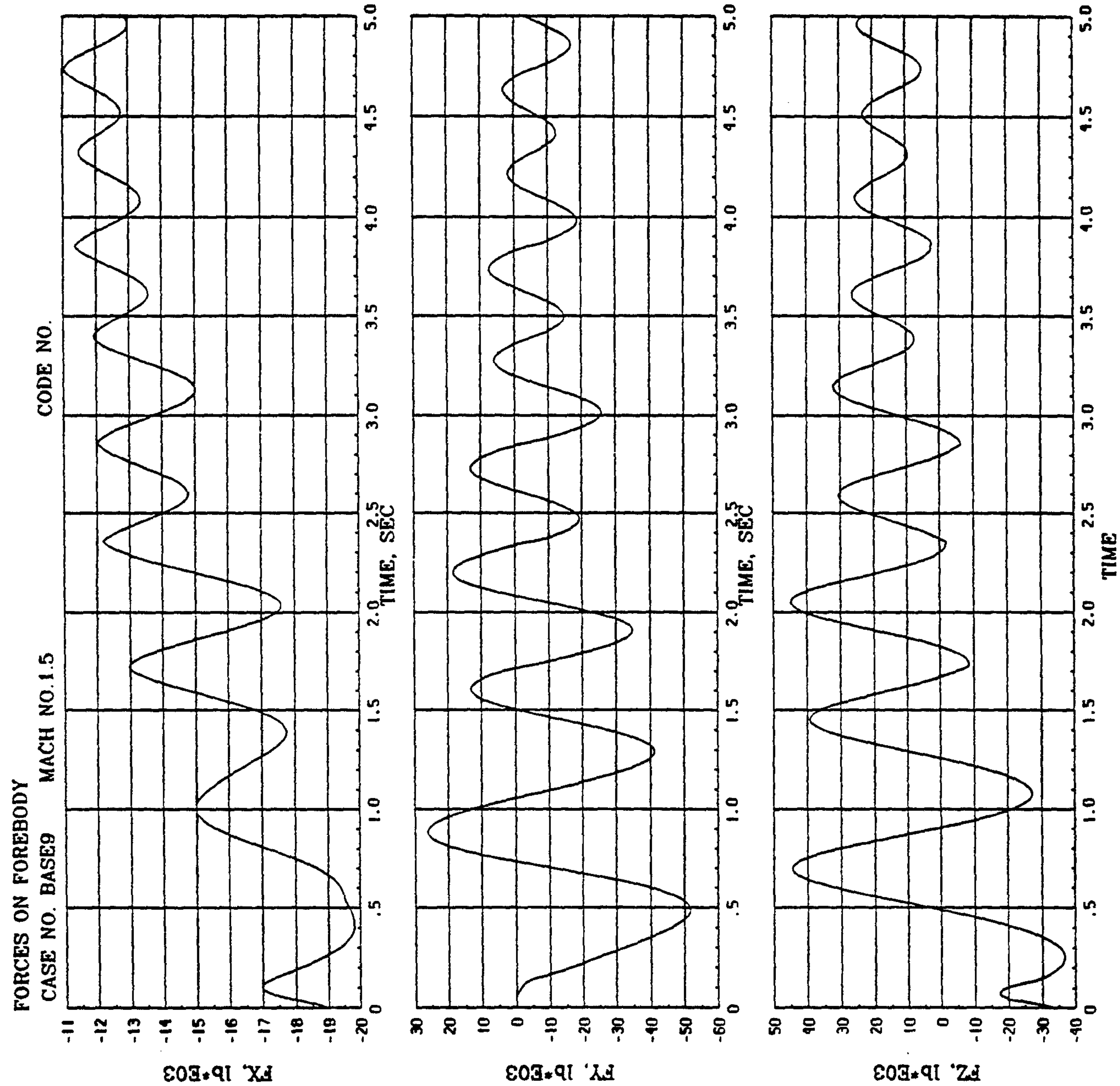

EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE9
MACH NO.1.5
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC

Case 3



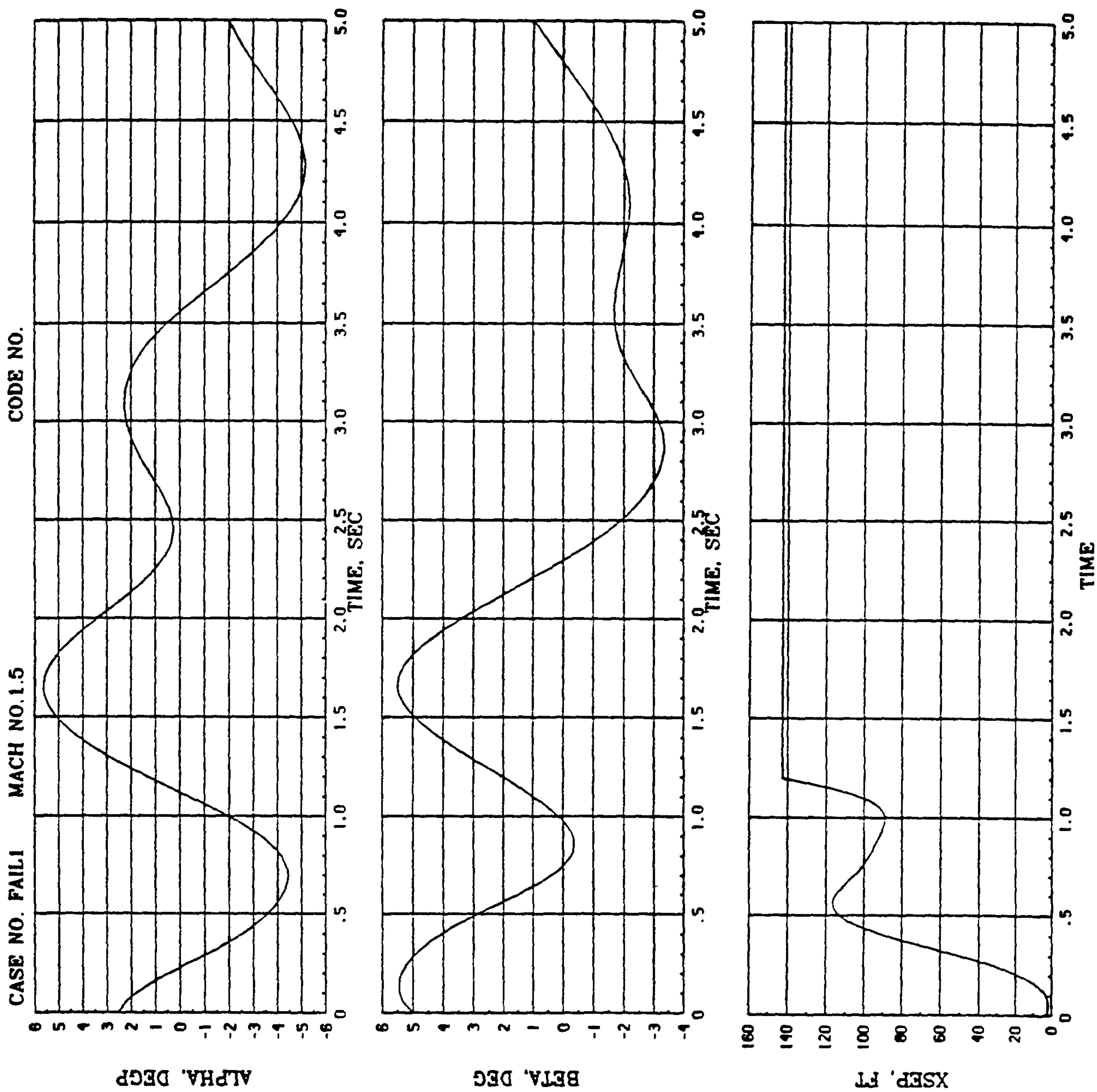
PITCH, YAW, ROLL RATES
CASE NO. BASE9
MACH NO.1.5
CODE NO.
P, DEG/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC

Case 3

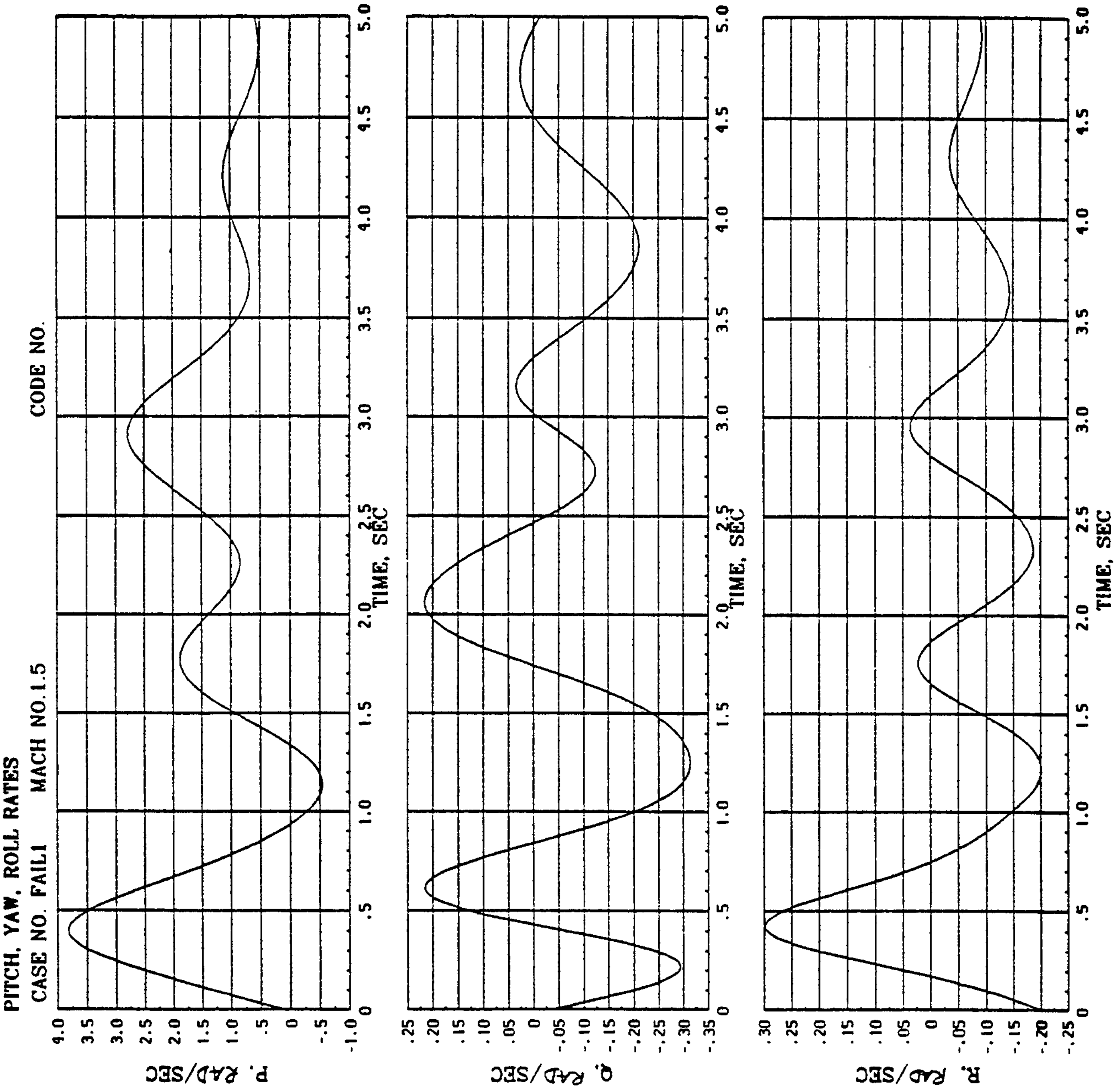


FORCES ON FOREBODY
CASE NO. BASE9
MACH NO.1.5
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

Case 4

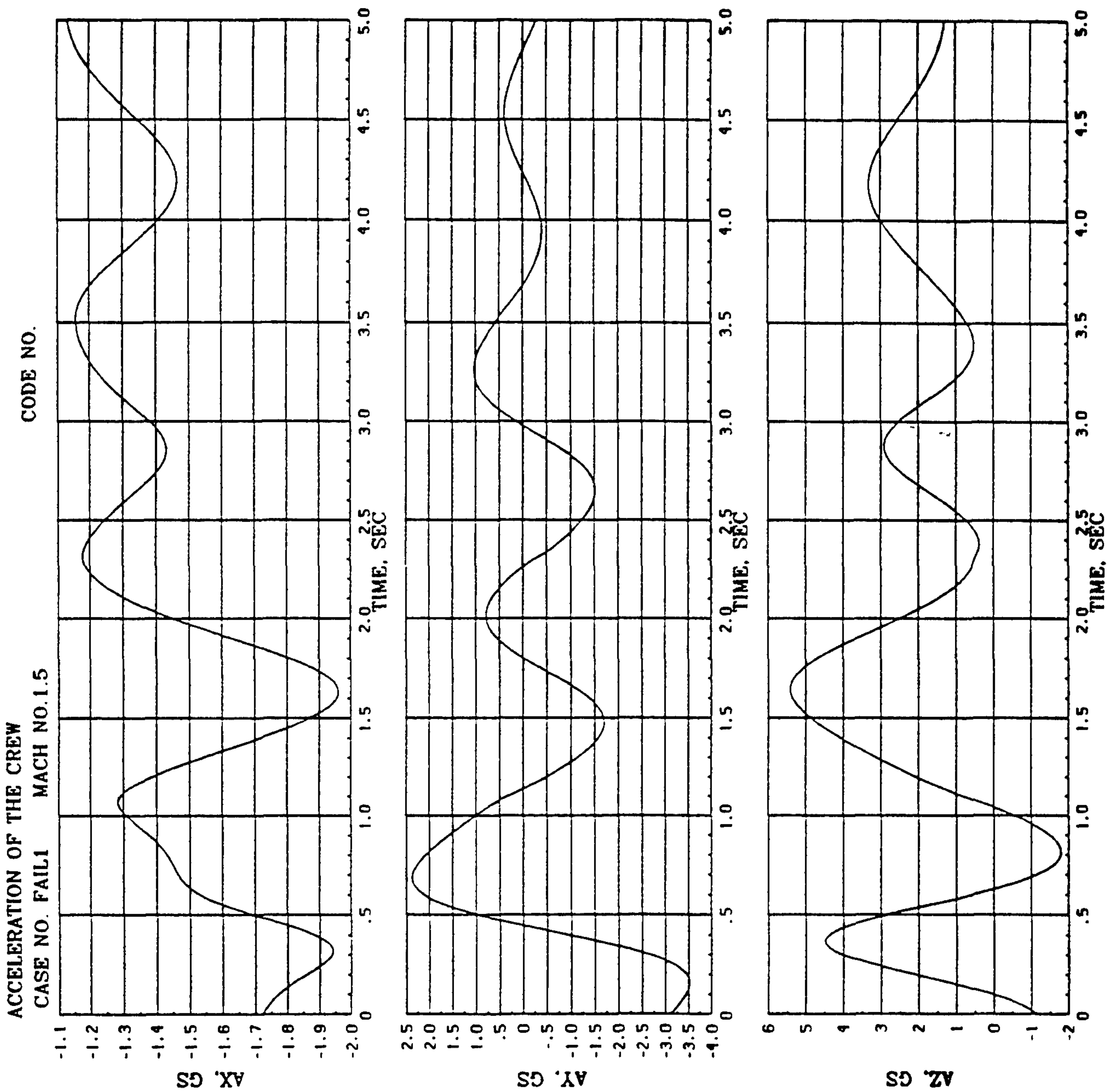

CASE NO. FAIL1
MACH NO.1.5
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

Case 4

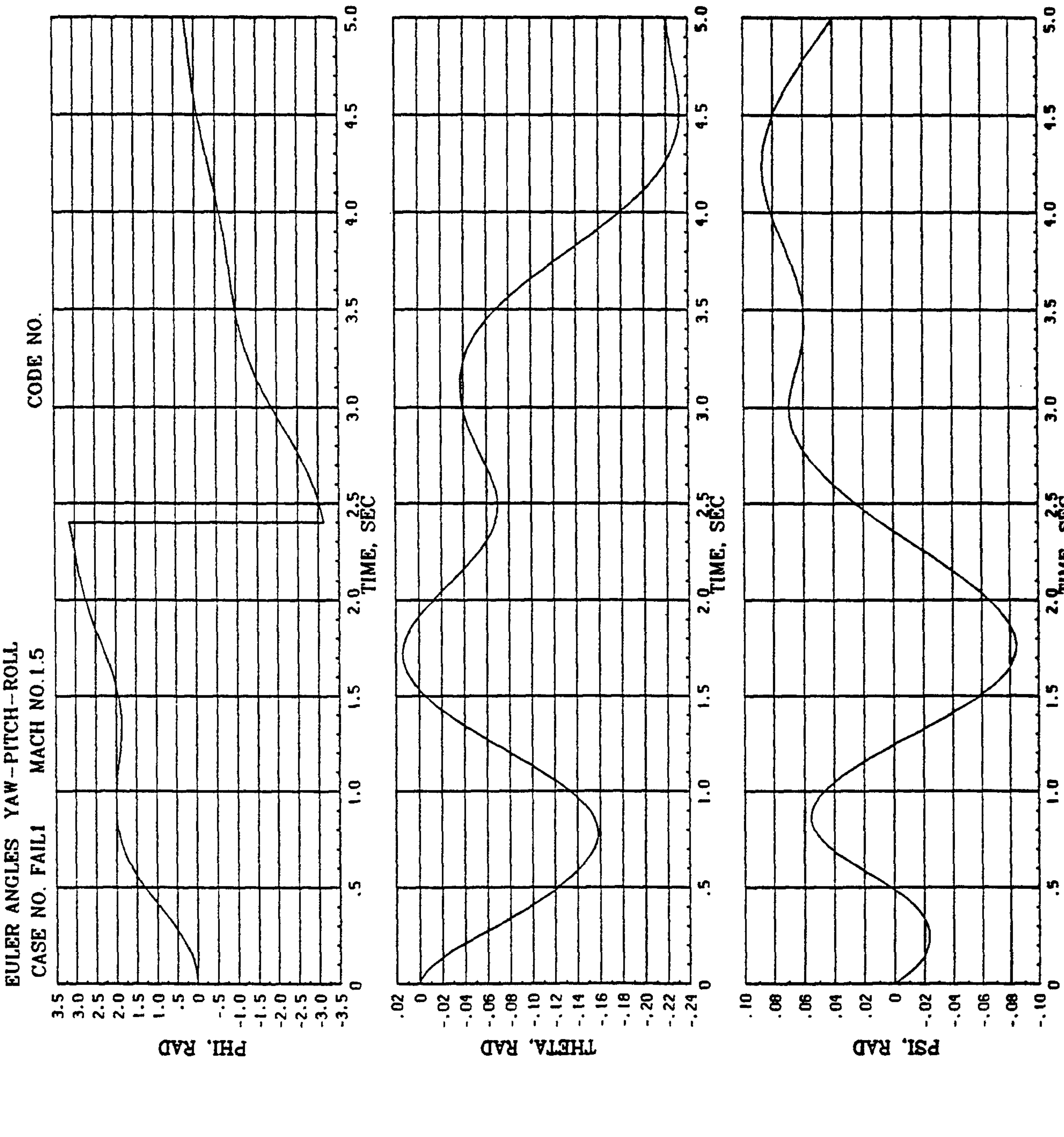


PITCH, YAW, ROLL RATES
CASE NO. FAIL1
MACH NO.1.5
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC
TIME, SEC
TIME, SEC

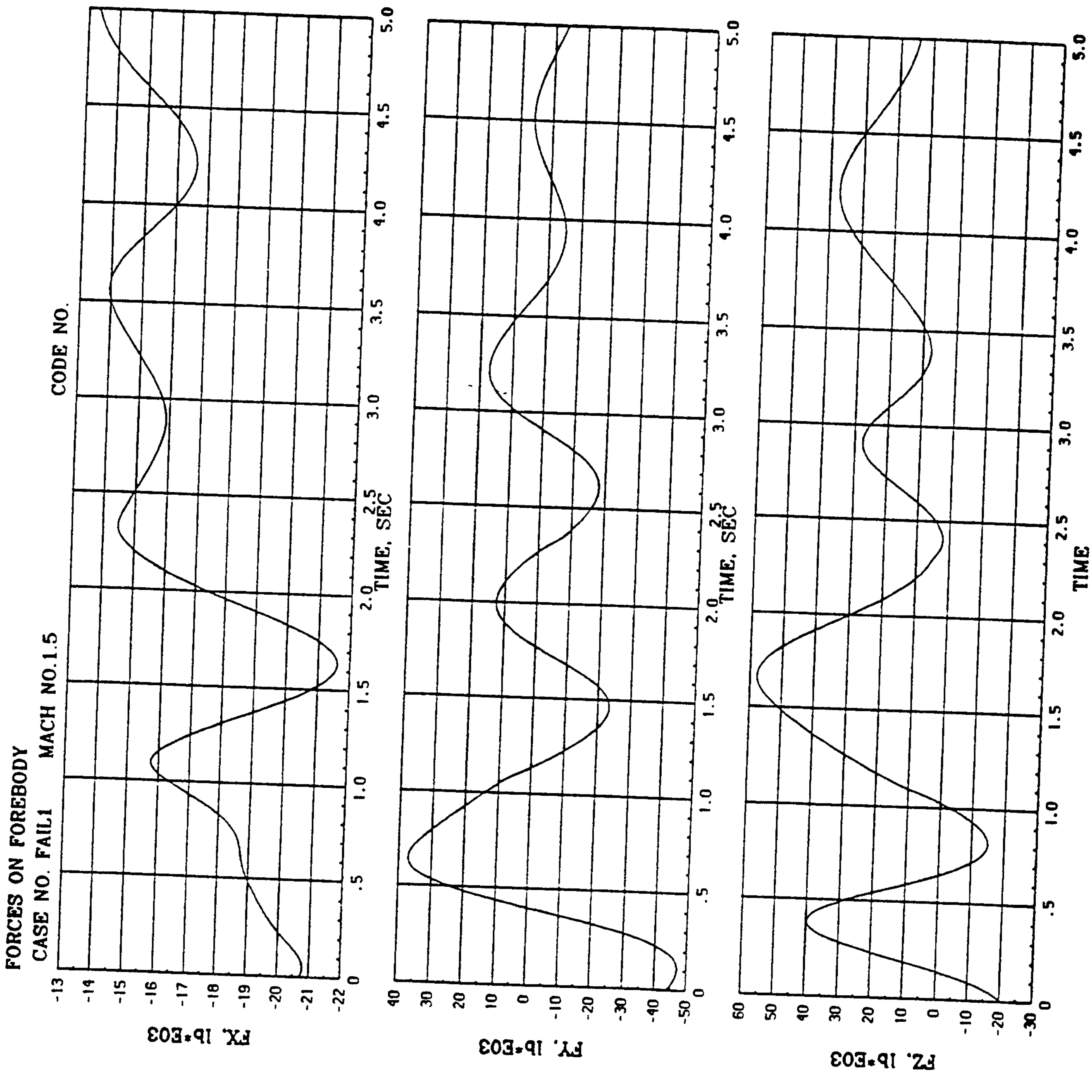
Case 4


ACCELERATION OF THE CREW
CASE NO. FAIL1
MACH NO.1.5
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 4

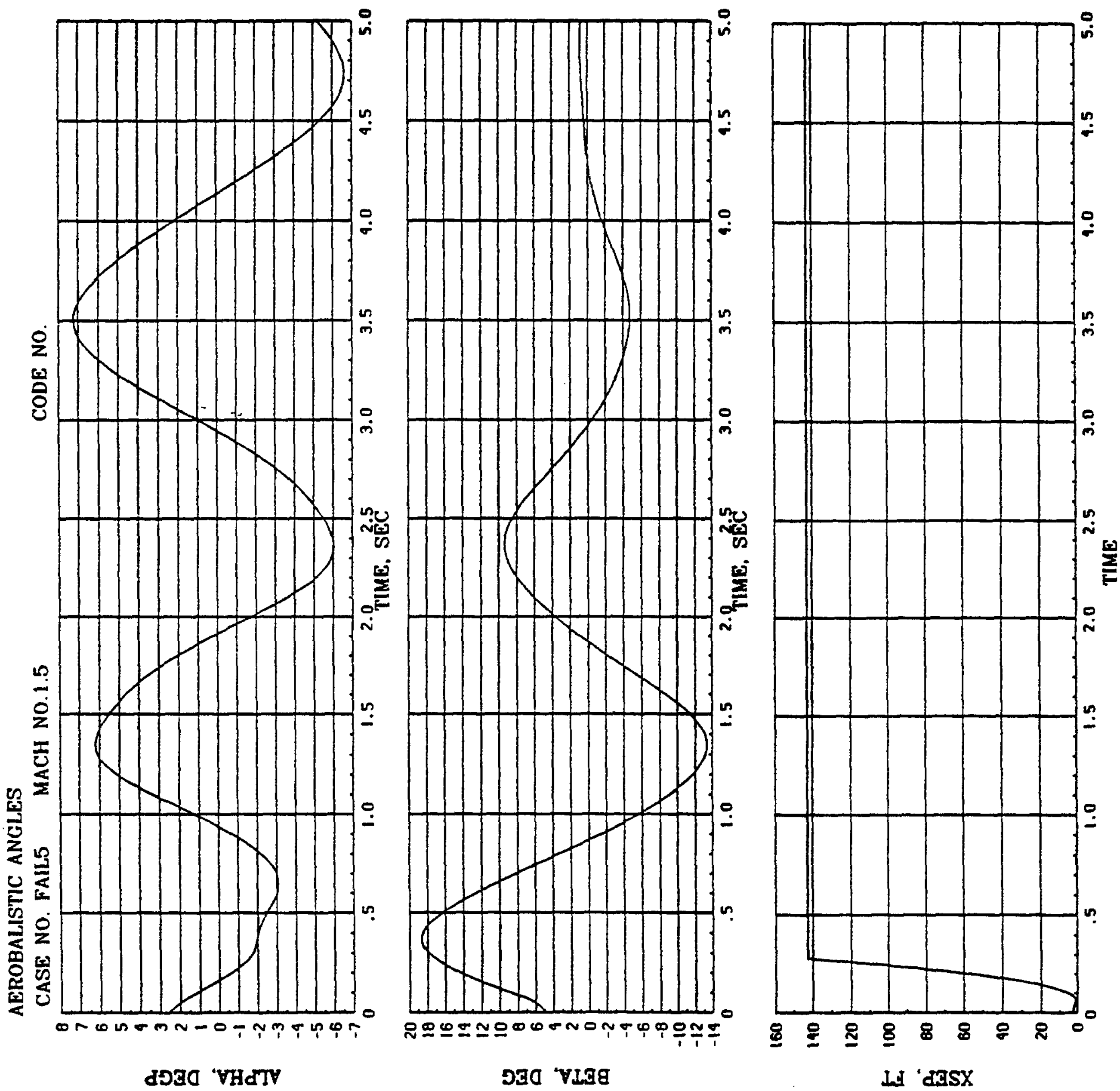

EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL1 MACH NO.1.5
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
TIME, SEC
TIME, SEC

Case 4

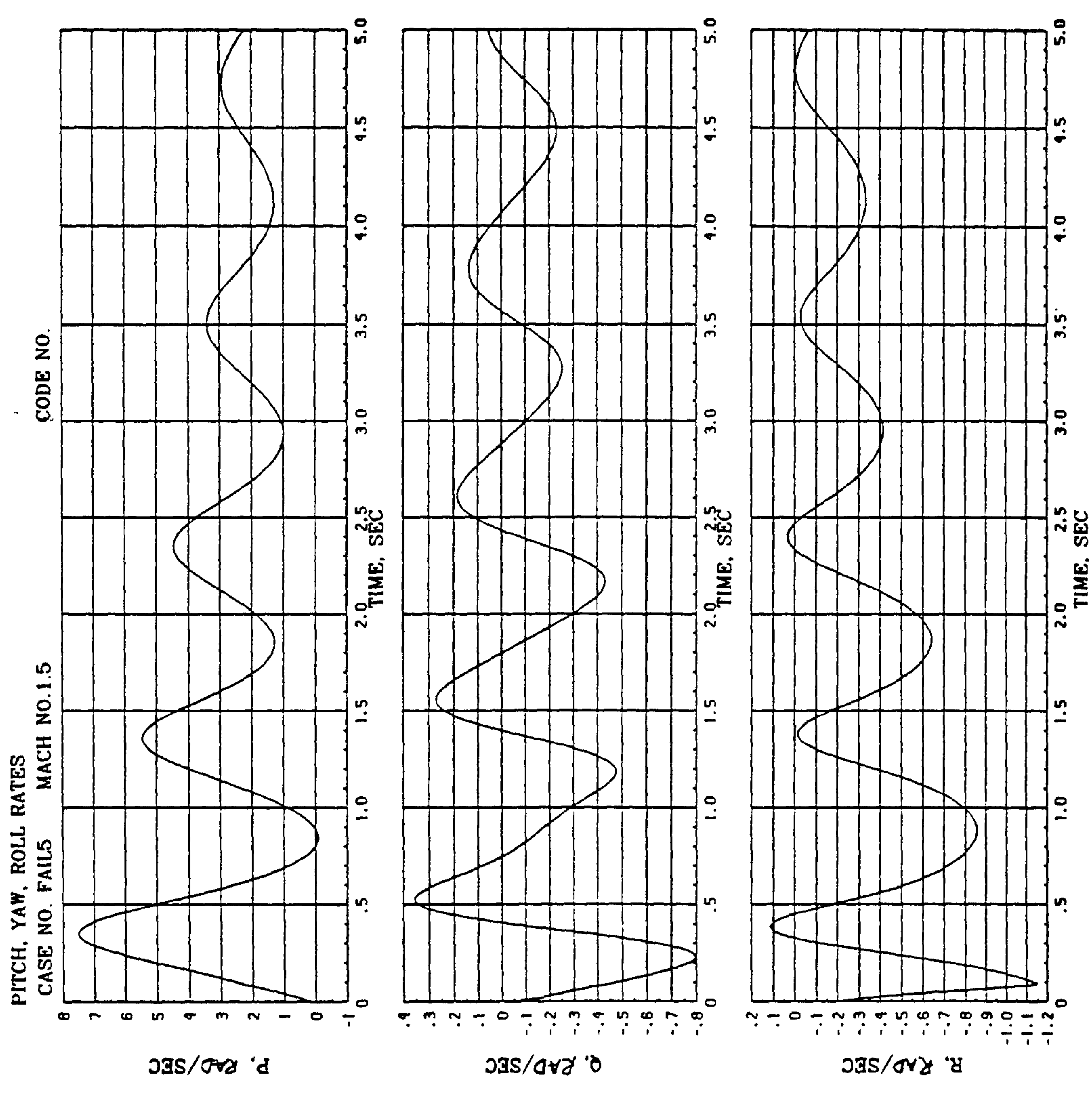


FORCES ON FOREBODY
CASE NO. FAIL1
MACH NO.1.5
CODE NO.
TIME, SEC
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME

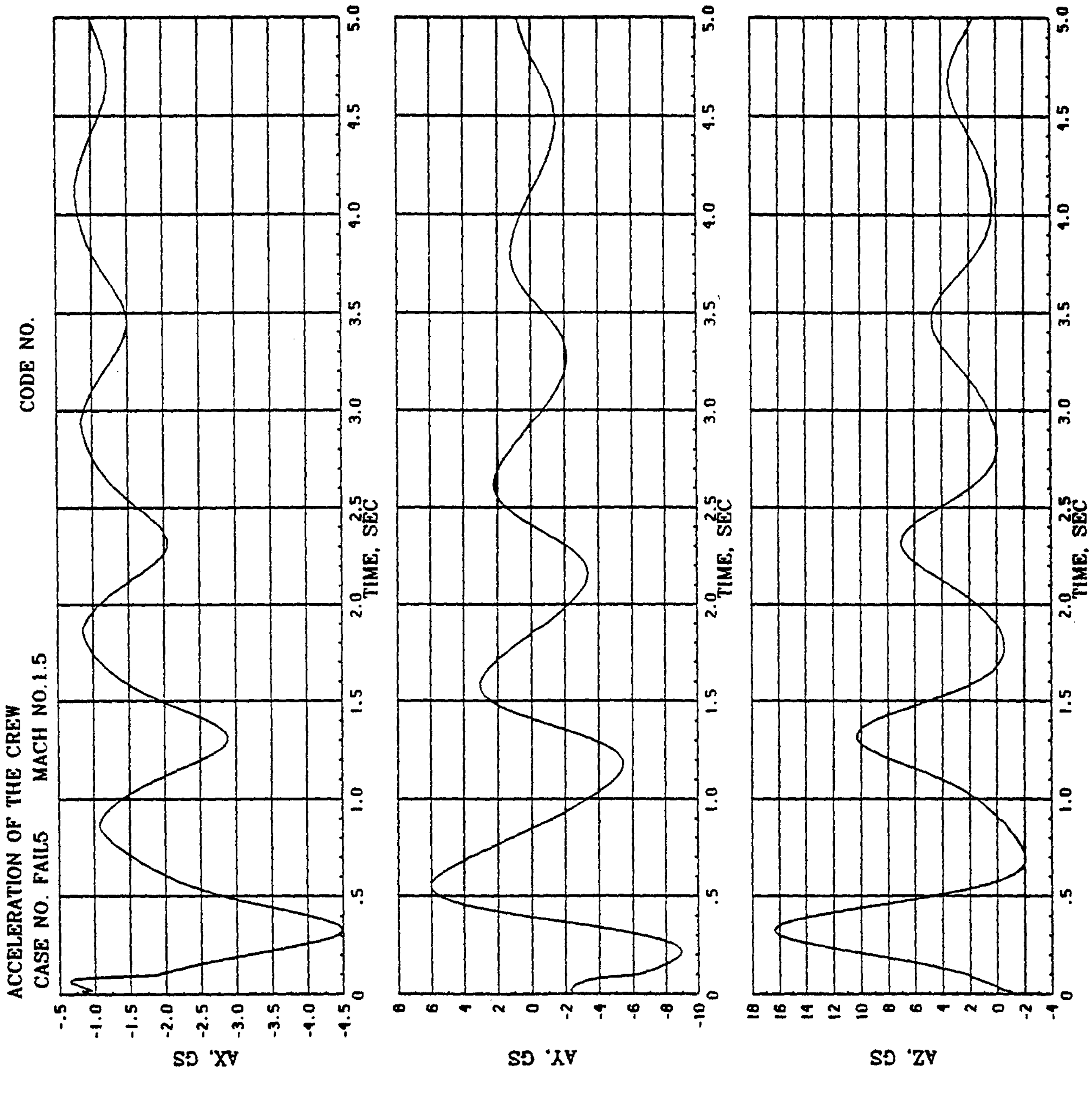
Case 5


AEROBALISTIC ANGLES
CASE NO. FAIL5
MACH NO.1.5
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

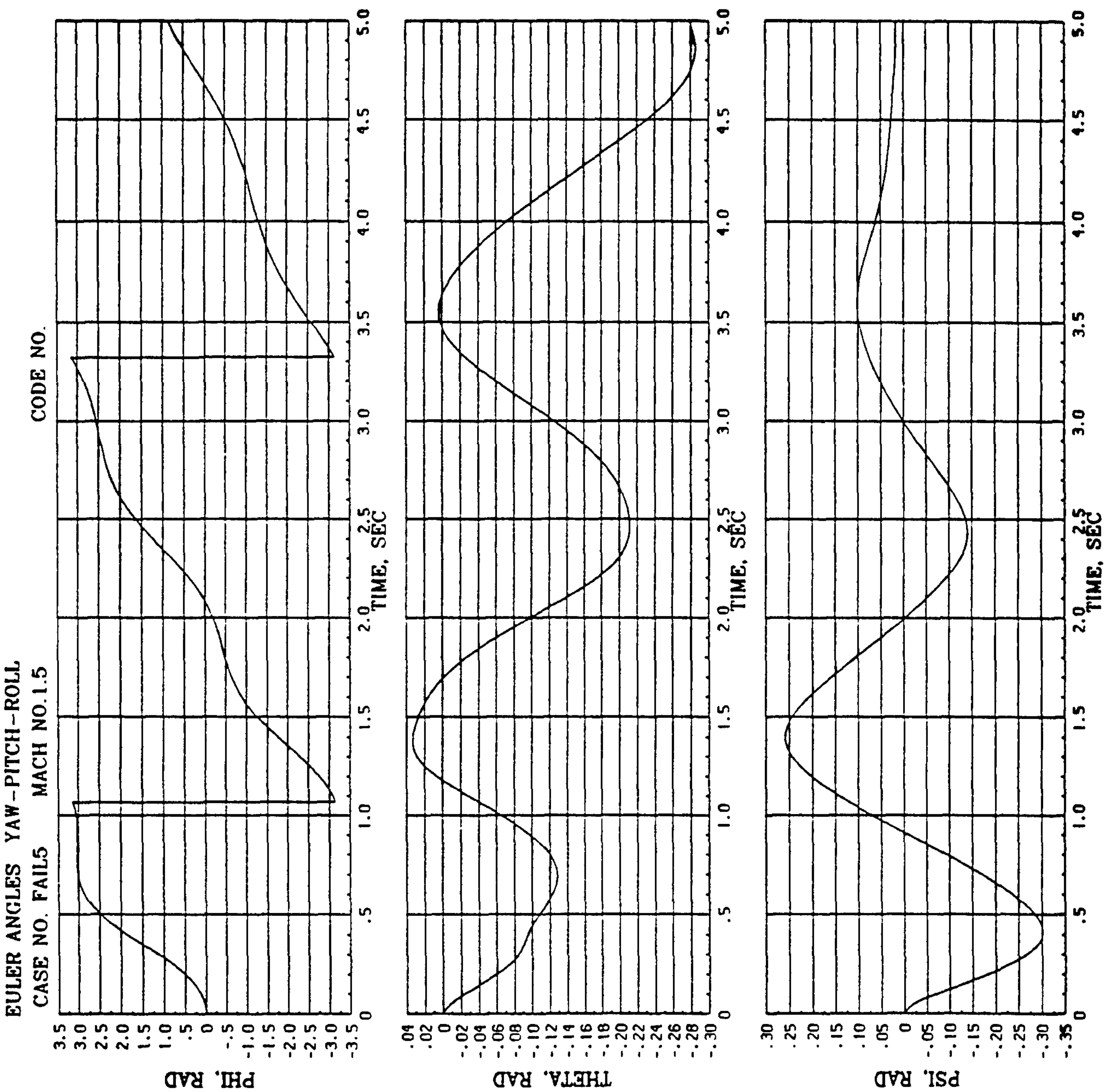
Case 5


PITCH, YAW, ROLL RATES
CASE NO. FAIL5
MACH NO.1.5
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC

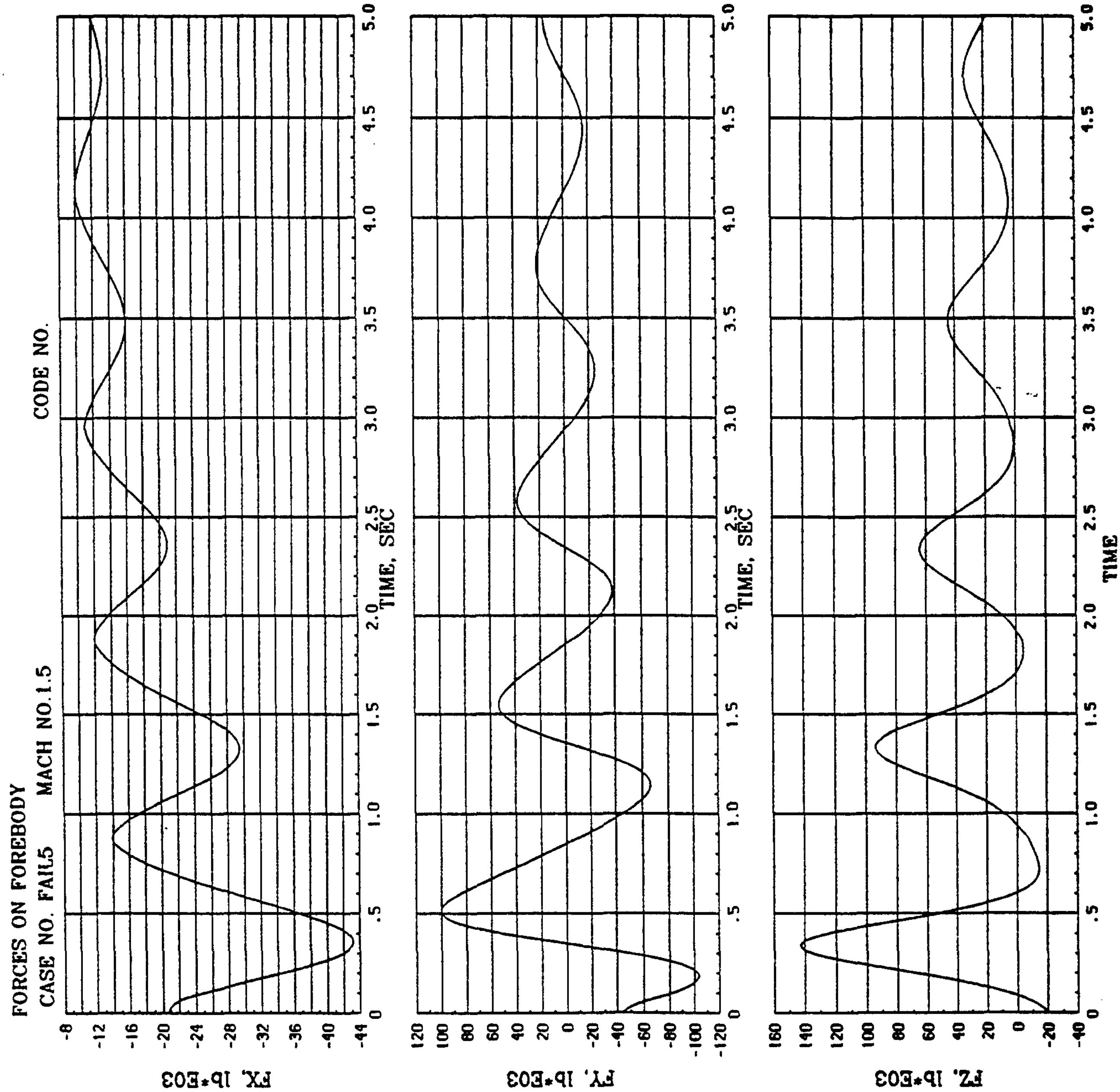
Case 5


ACCELERATION OF THE CREW
CASE NO. FAIL5
MACH NO.1.5
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 5

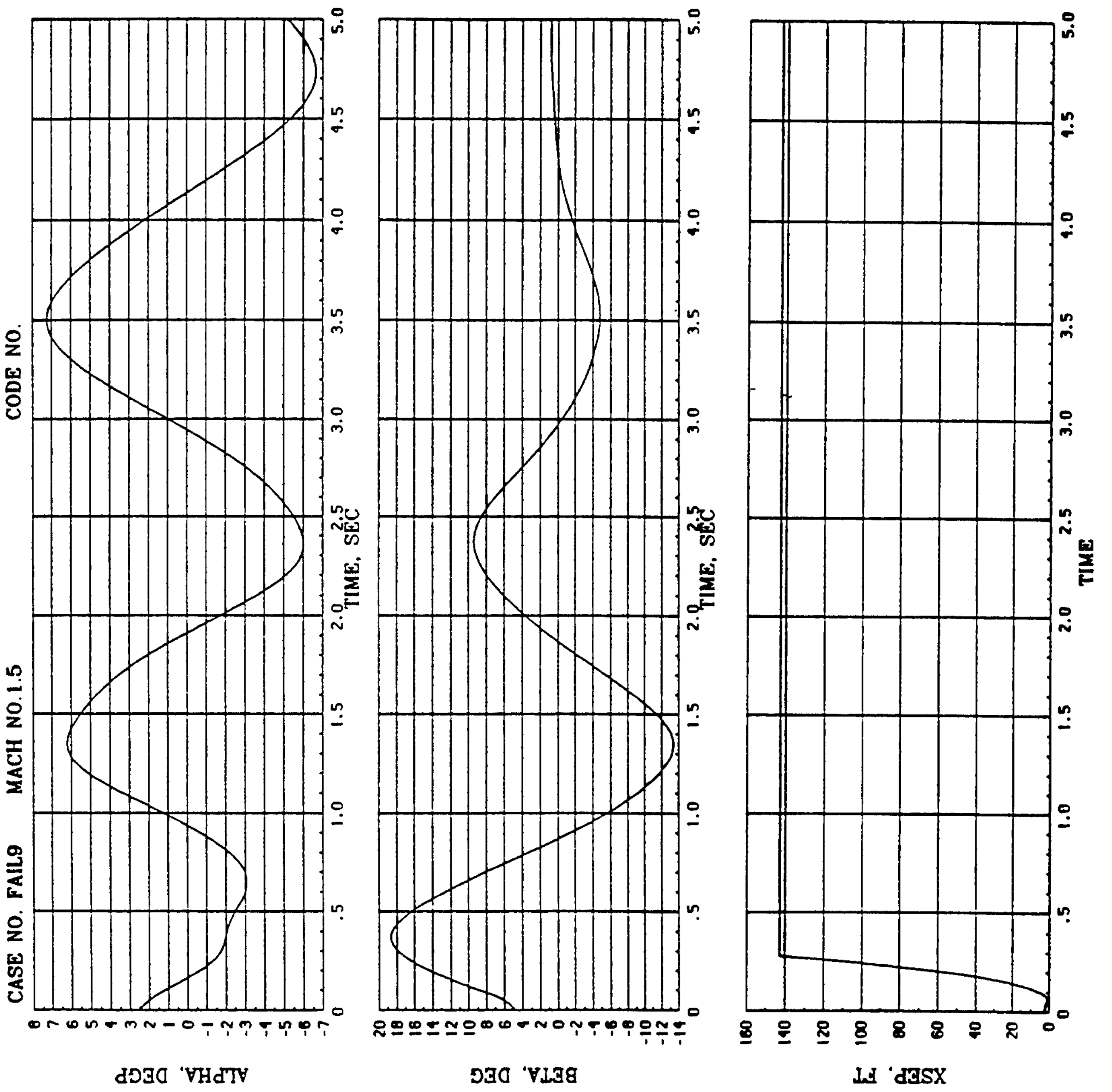

EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL5
MACH NO.1.5
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
TIME, SEC
TIME, SEC

Case 5

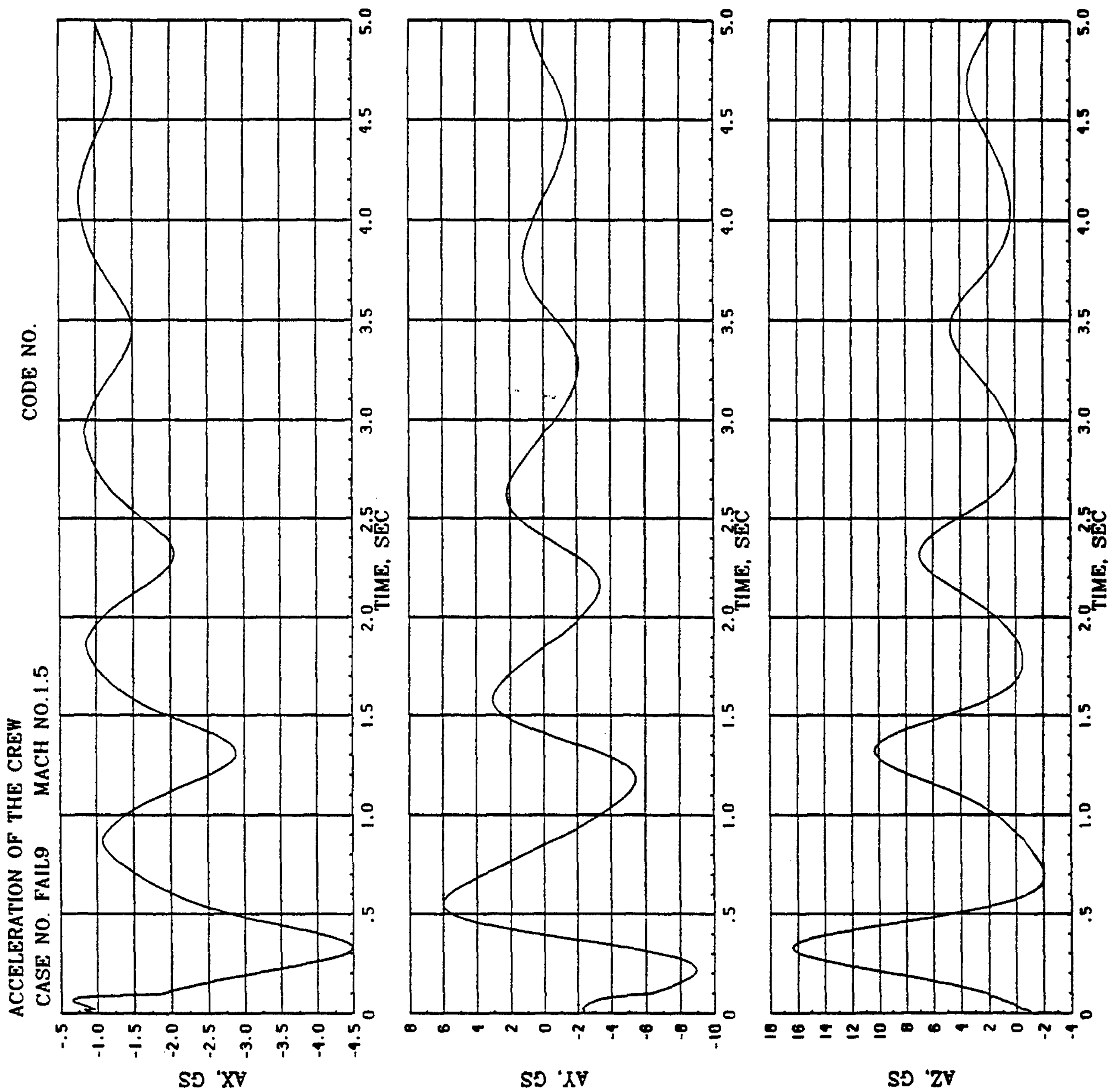


FORCES ON FOREBODY
CASE NO. FAIL5
MACH NO.1.5
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

Case 6

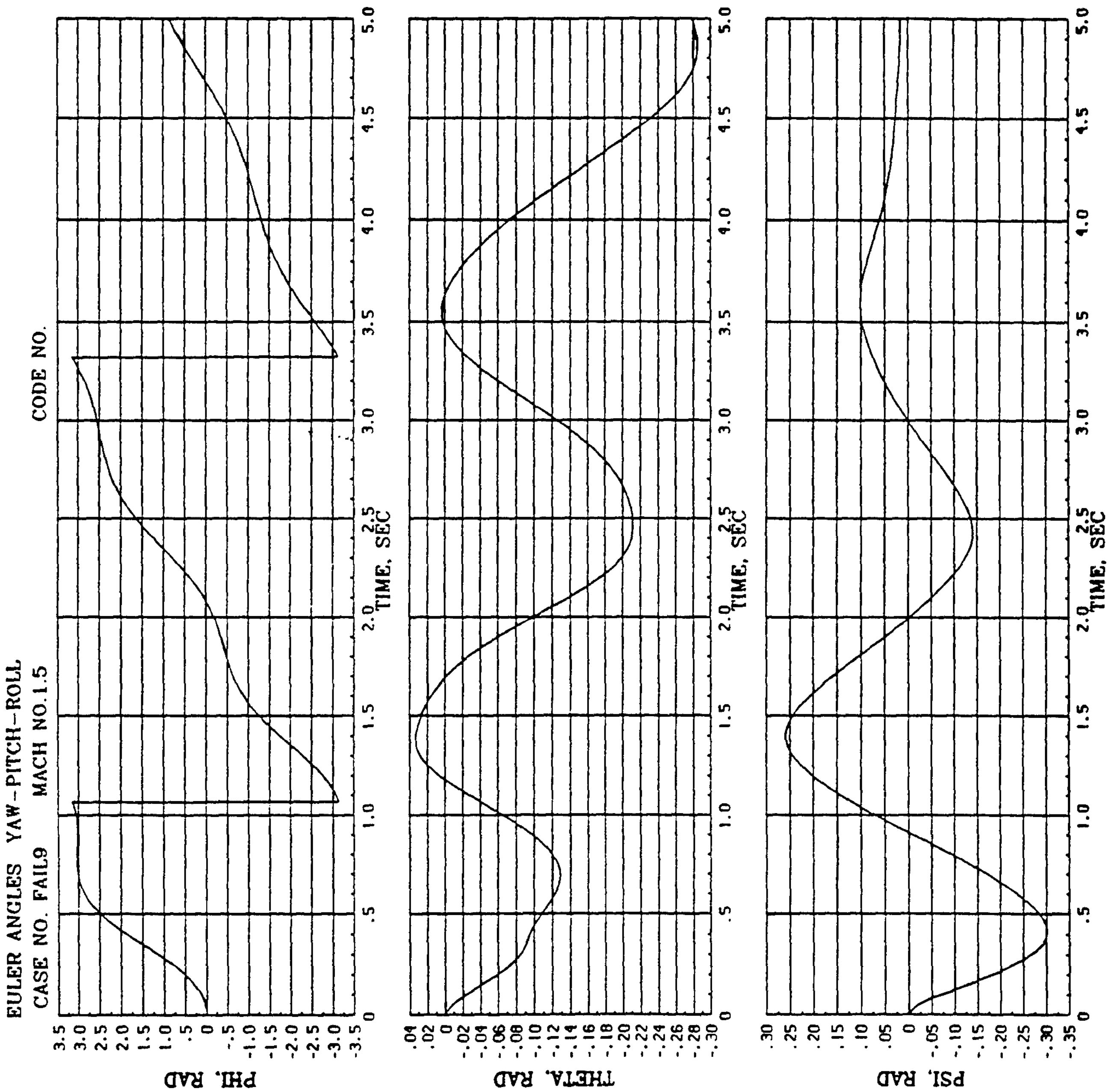

CASE NO. FAIL9
MACH NO.1.5
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

Case 6



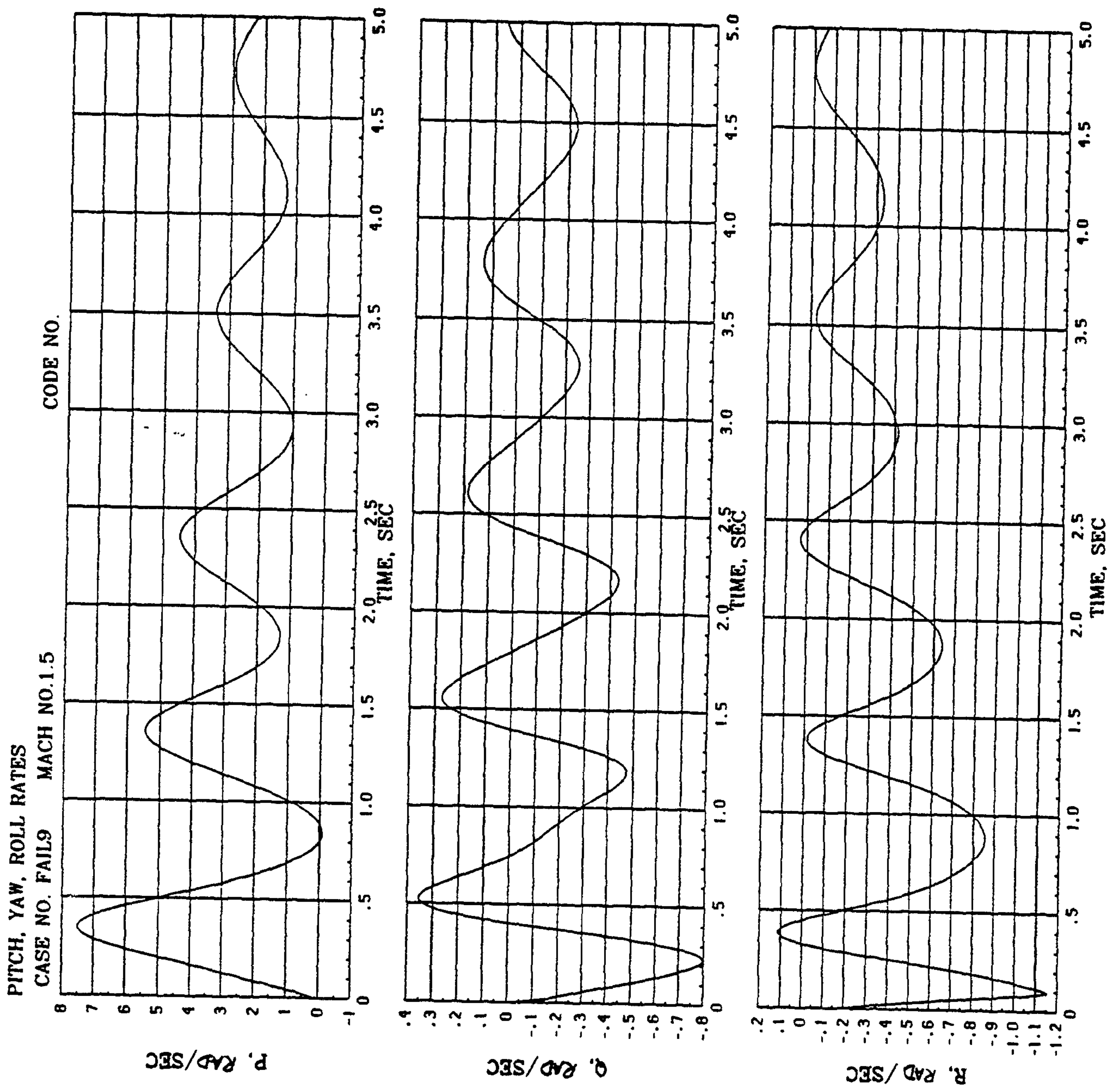
ACCELERATION OF THE CREW
CASE NO. FAIL9
MACH NO.1.5
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
TIME, SEC
TIME, SEC

Case 6

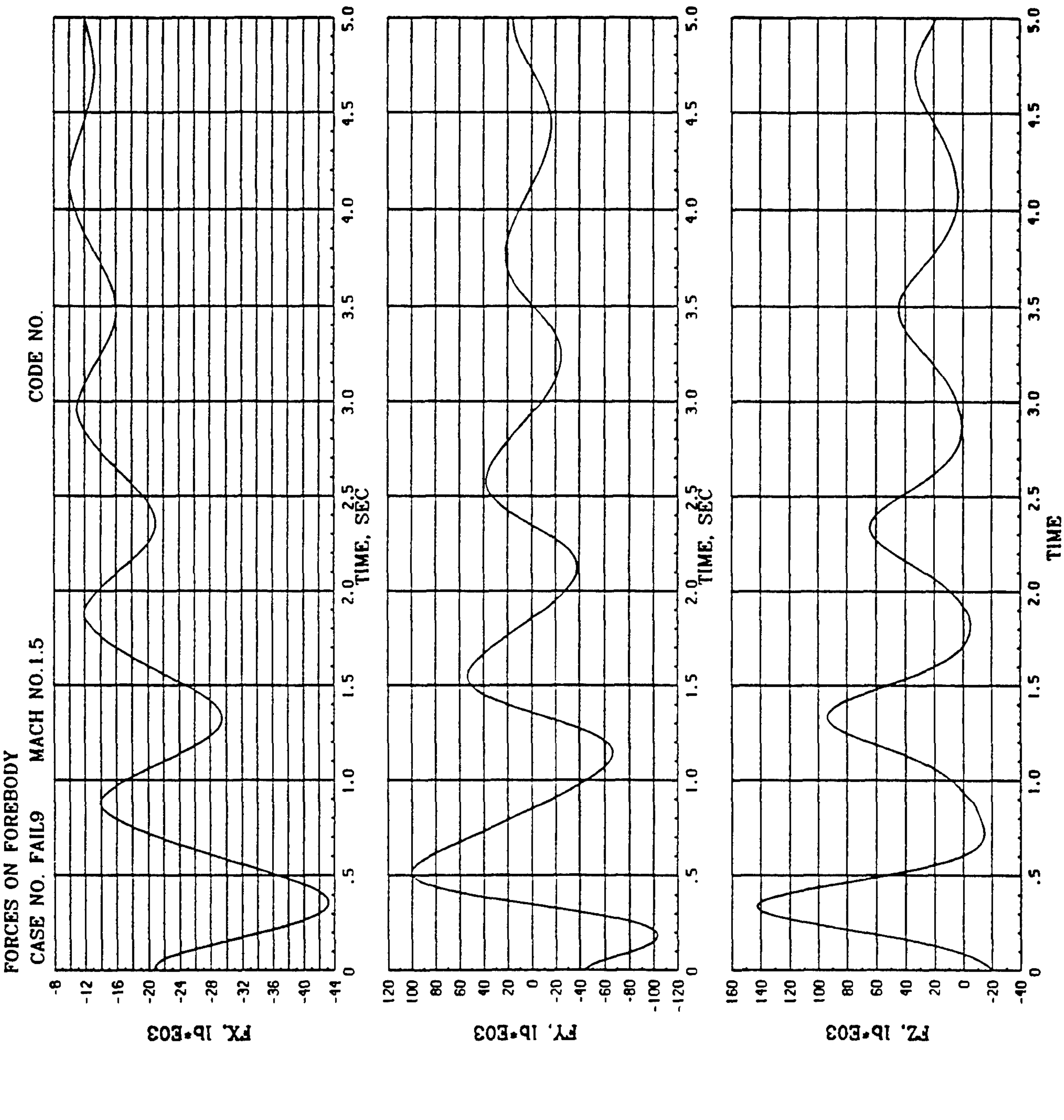


EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL9
MACH NO.1.5
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC

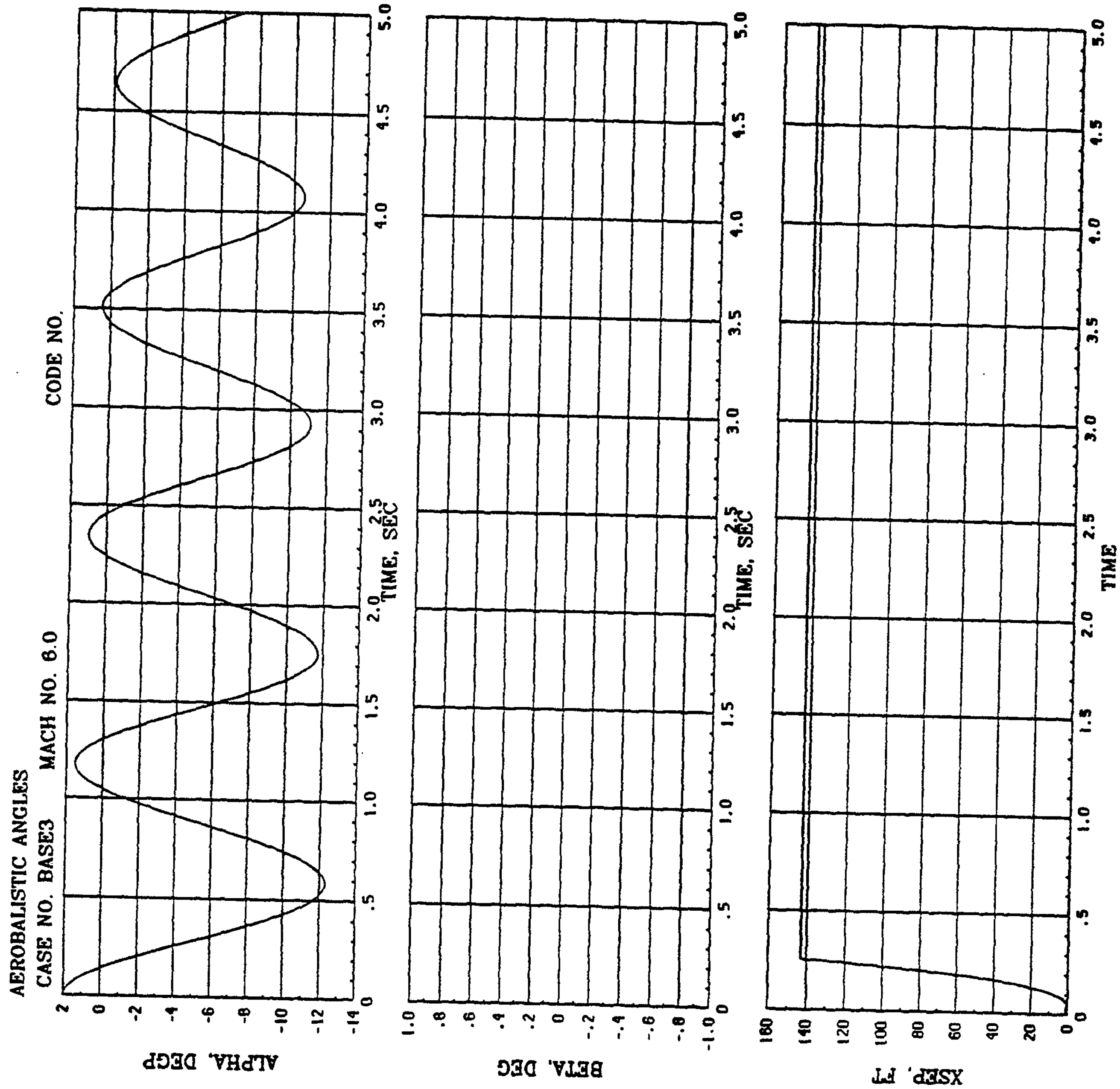
Case 6


PITCH, YAW, ROLL RATES
CASE NO. FAIL9
MACH NO.1.5
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC

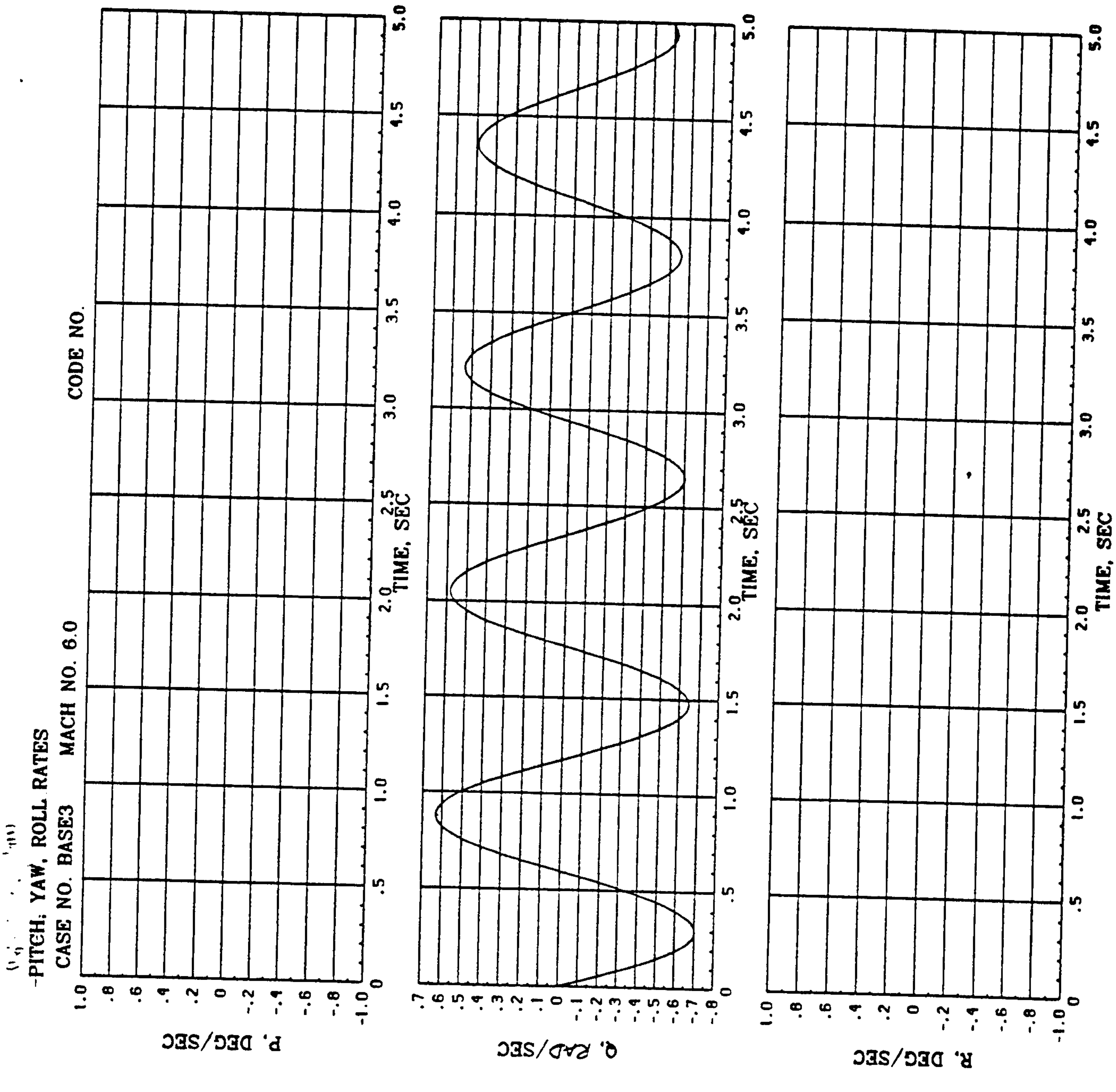
Case 6

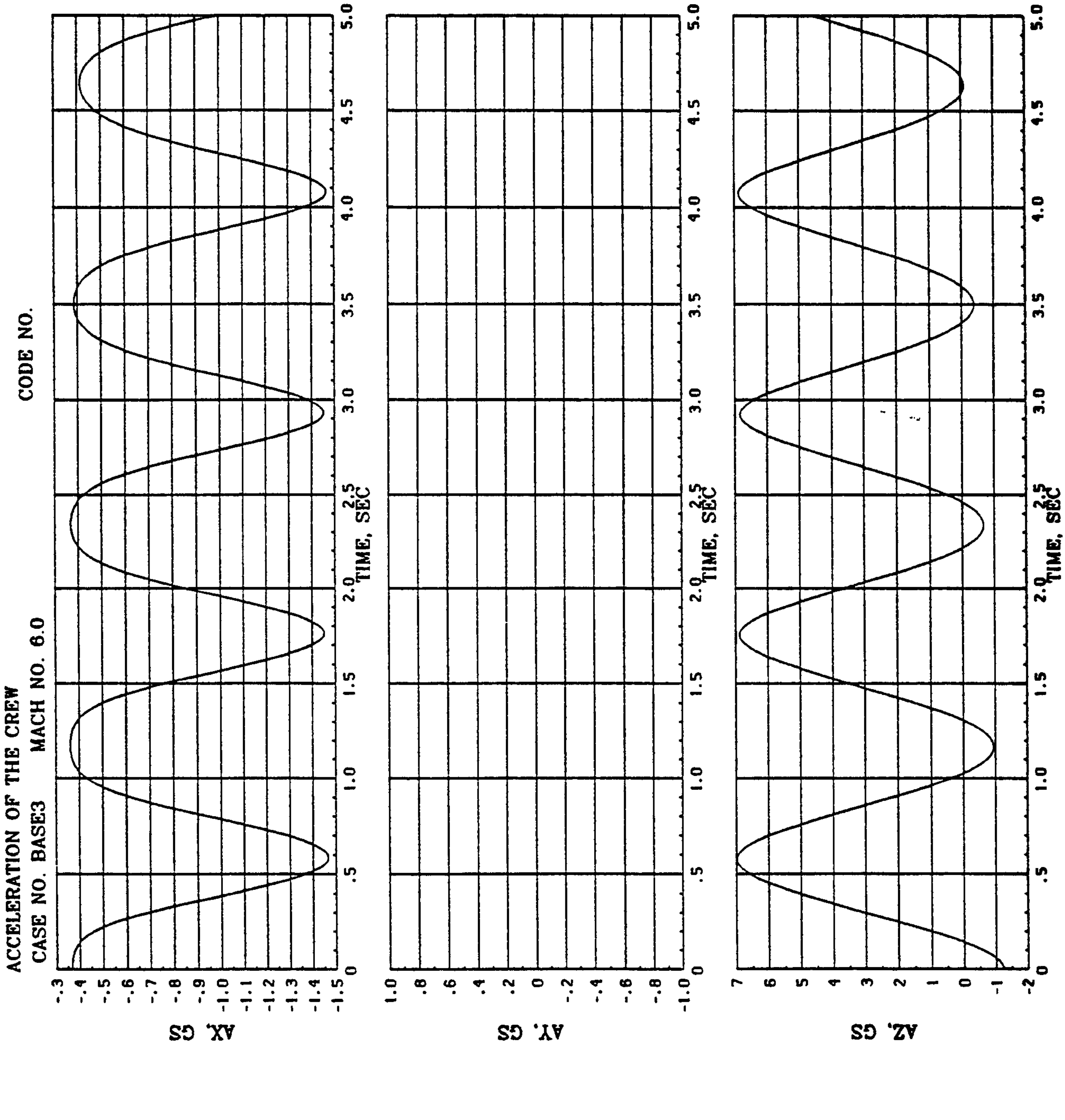

FORCES ON FOREBODY
CASE NO. FAIL9
MACH NO.1.5
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

Case 7

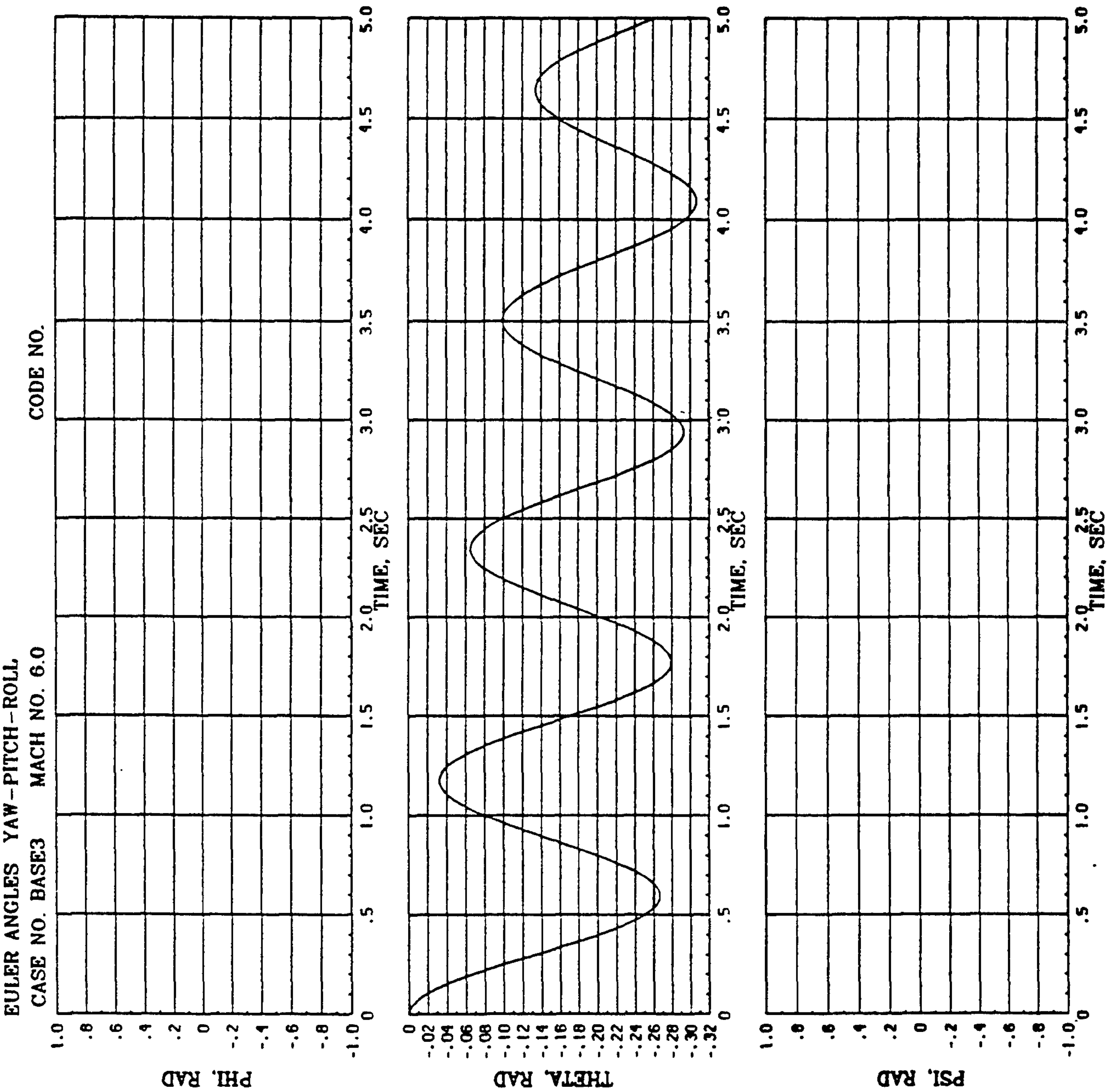


AEROBALISTIC ANGLES
CASE NO. BASE3
MACH NO. 6.0
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME


PITCH, YAW, ROLL RATES
CASE NO. BASE3
MACH NO. 6.0
CODE NO.
P, DEG/SEC
Q, RAD/SEC
R, DEG/SEC
TIME, SEC

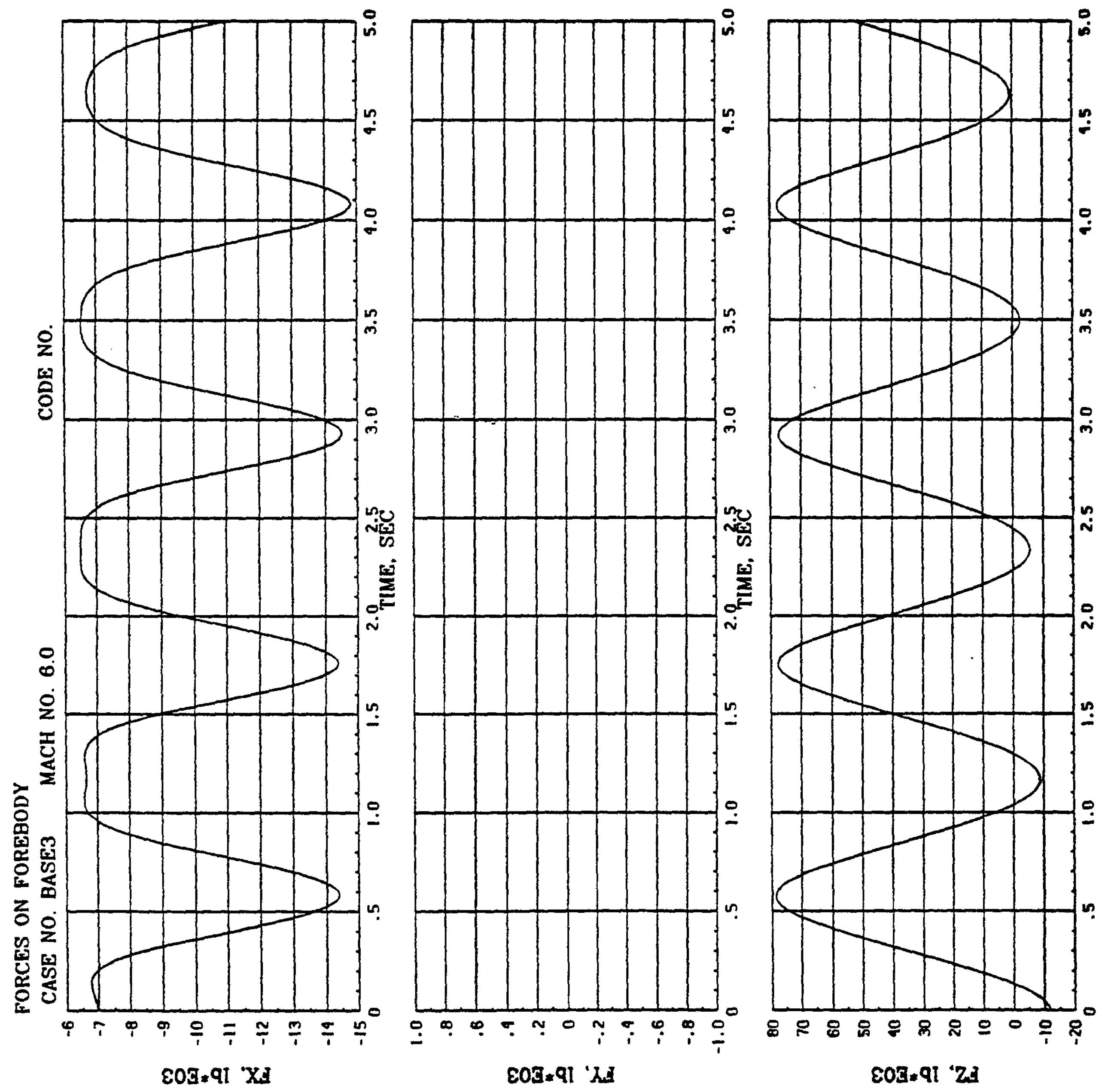

ACCELERATION OF THE CREW
CASE NO. BASE3
MACH NO. 6.0
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
TIME, SEC
TIME, SEC

Case 7

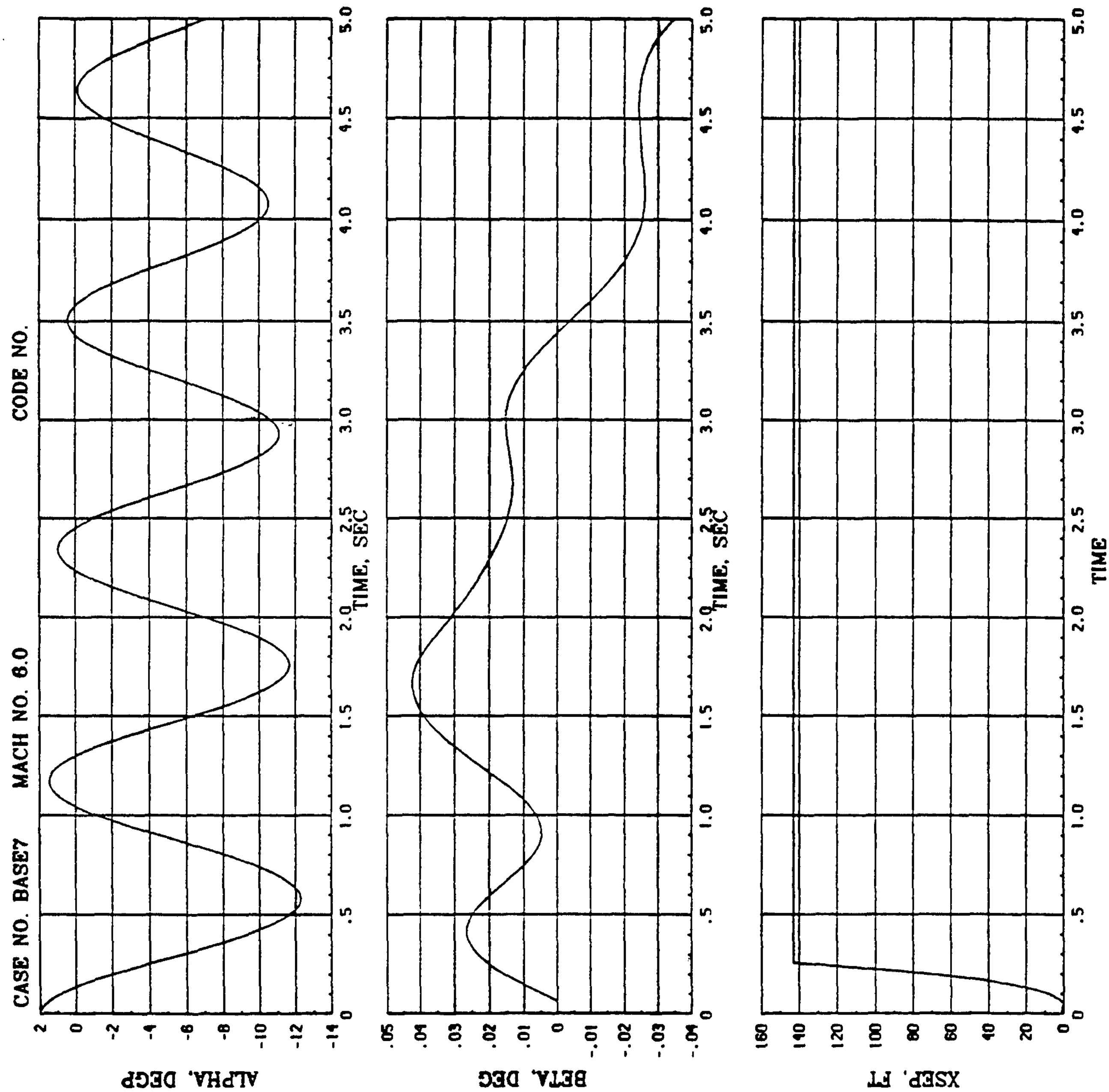


EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE3
MACH NO. 6.0
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
1.0
.8
.6
.4
.2
0
-.2
-.4
-.6
-.8
-1.0
-.02
-.04
-.06
-.08
-.10
-.12
-.14
-.16
-.18
-.20
-.22
-.24
-.26
-.28
-.30
-.32

Case 7

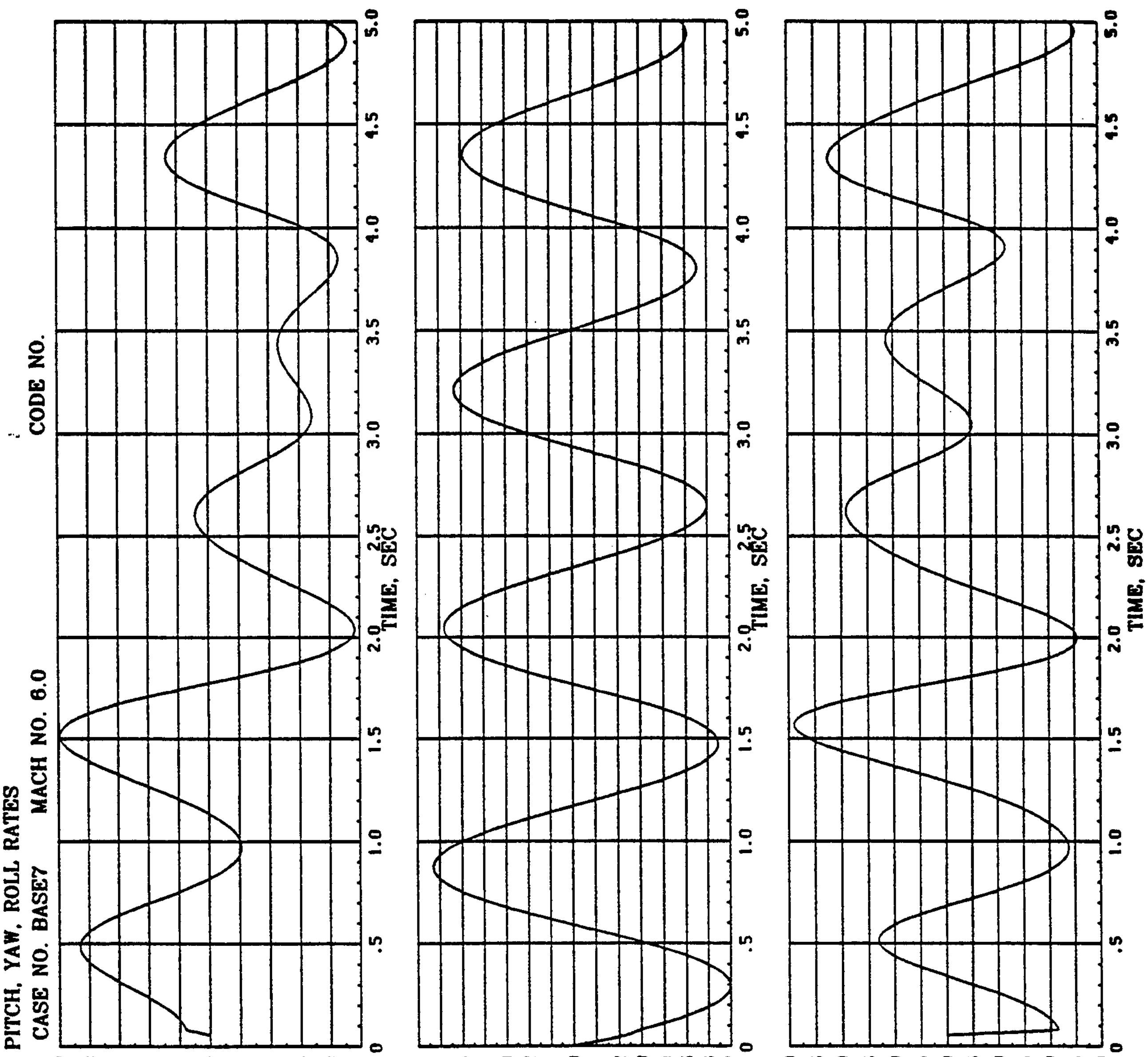

FORCES ON FOREBODY
CASE NO. BASE3
MACH NO. 6.0
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

Case 8

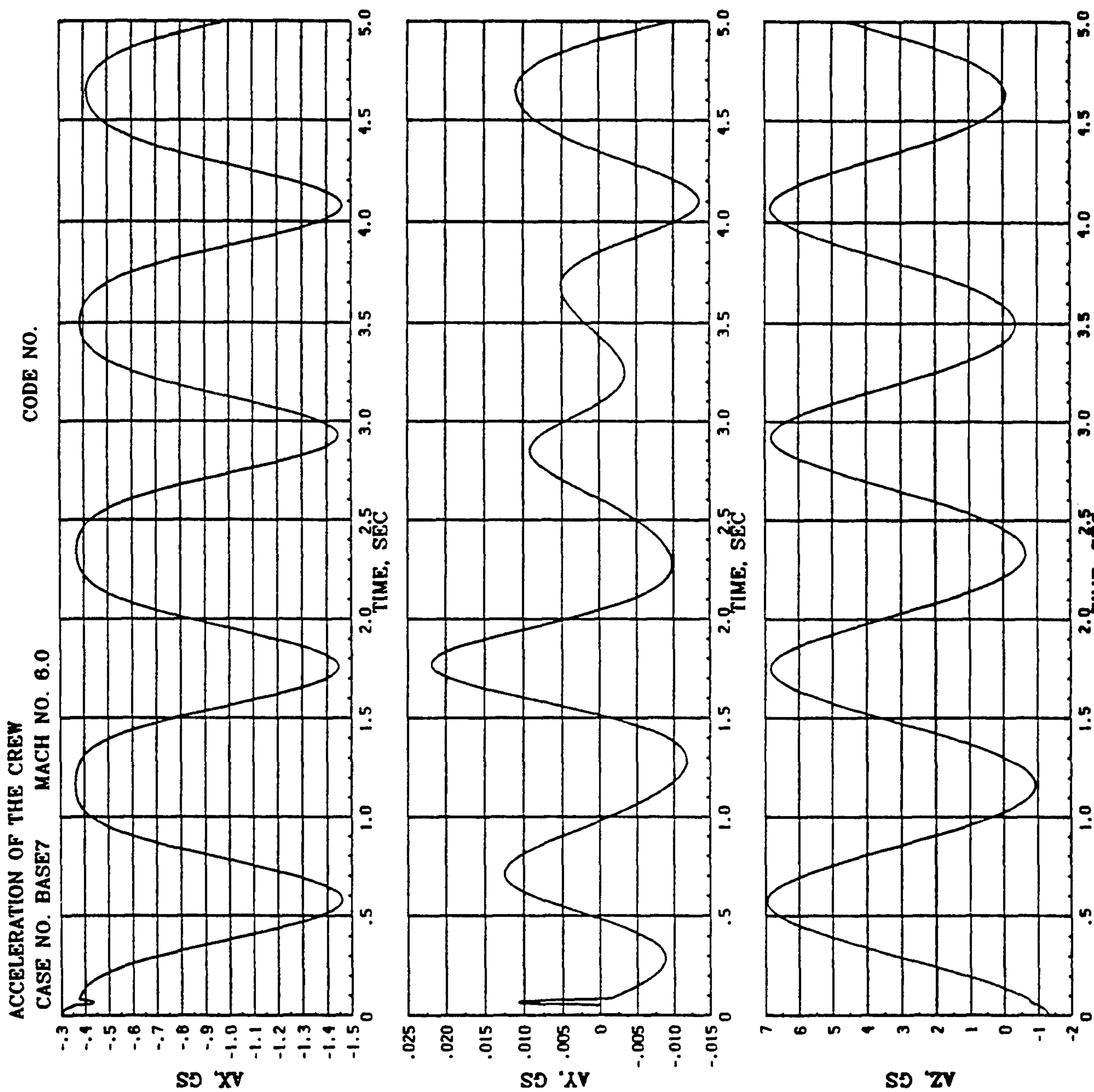


CASE NO. BASE7
MACH NO. 6.0
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

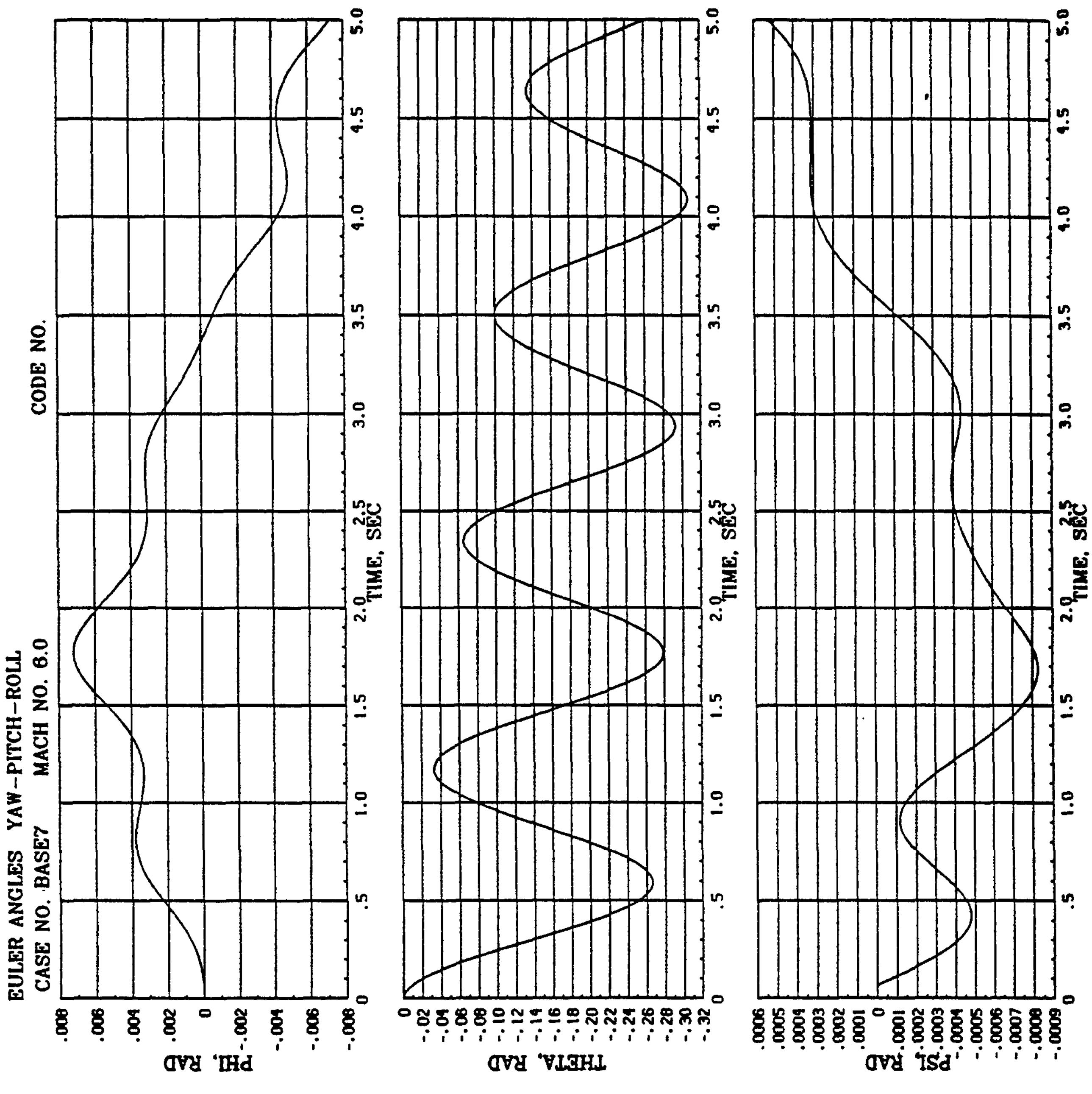
Case 8


PITCH, YAW, ROLL RATES
CASE NO. BASE7
MACH NO. 6.0
CODE NO.
TIME, SEC
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC

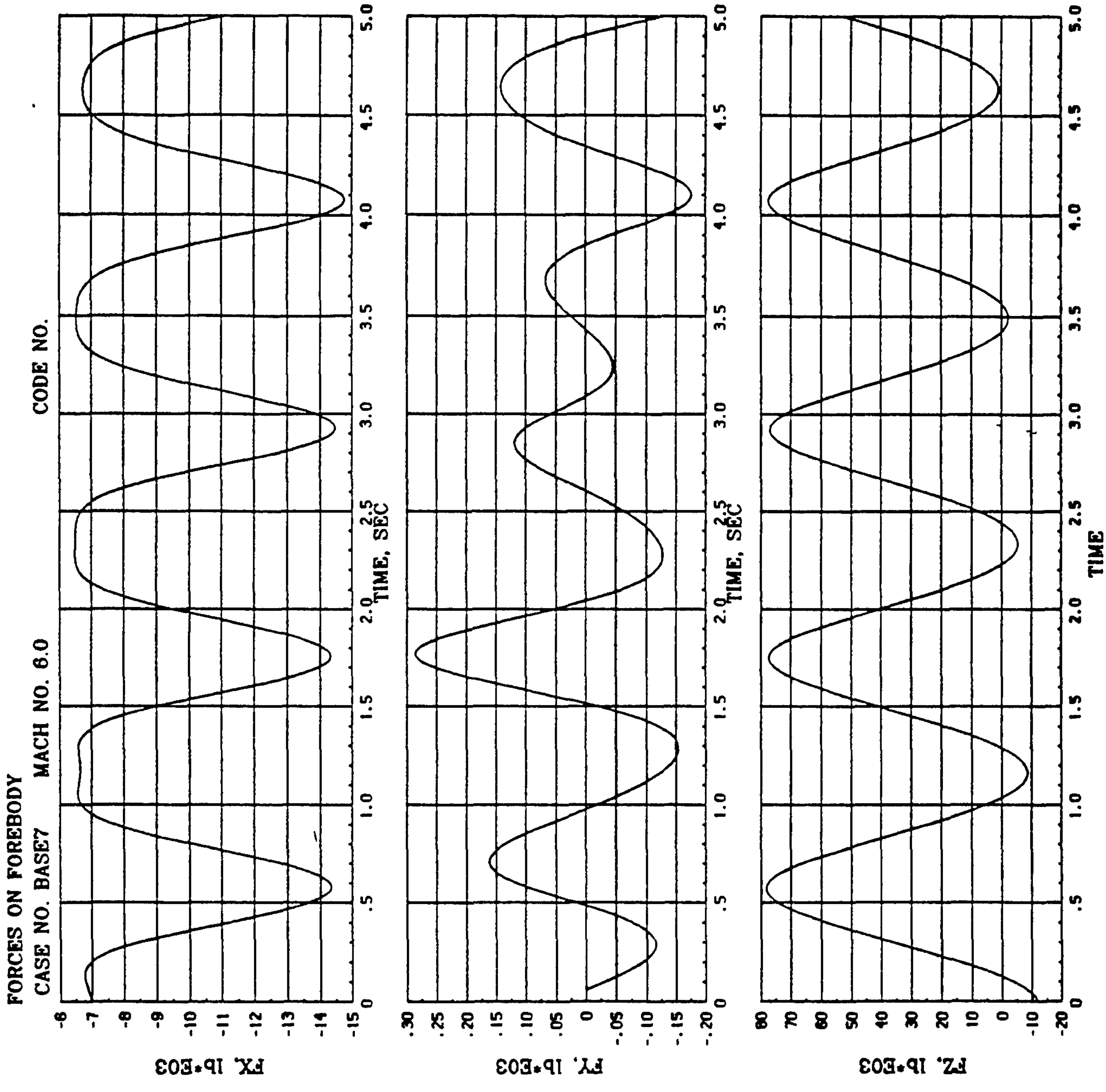
Case 8

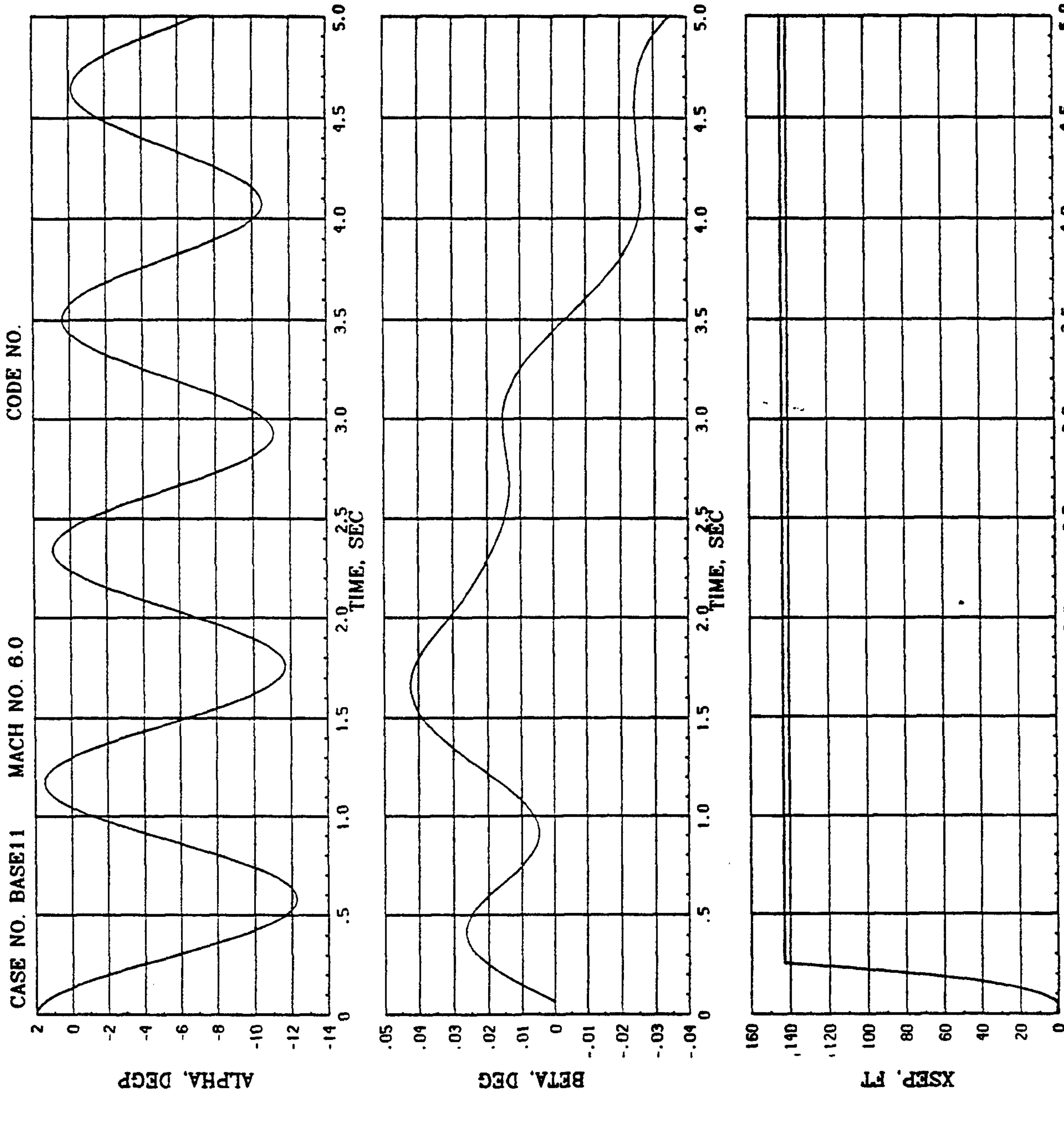

ACCELERATION OF THE CREW
CASE NO. BASE7
MACH NO. 8.0
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 8

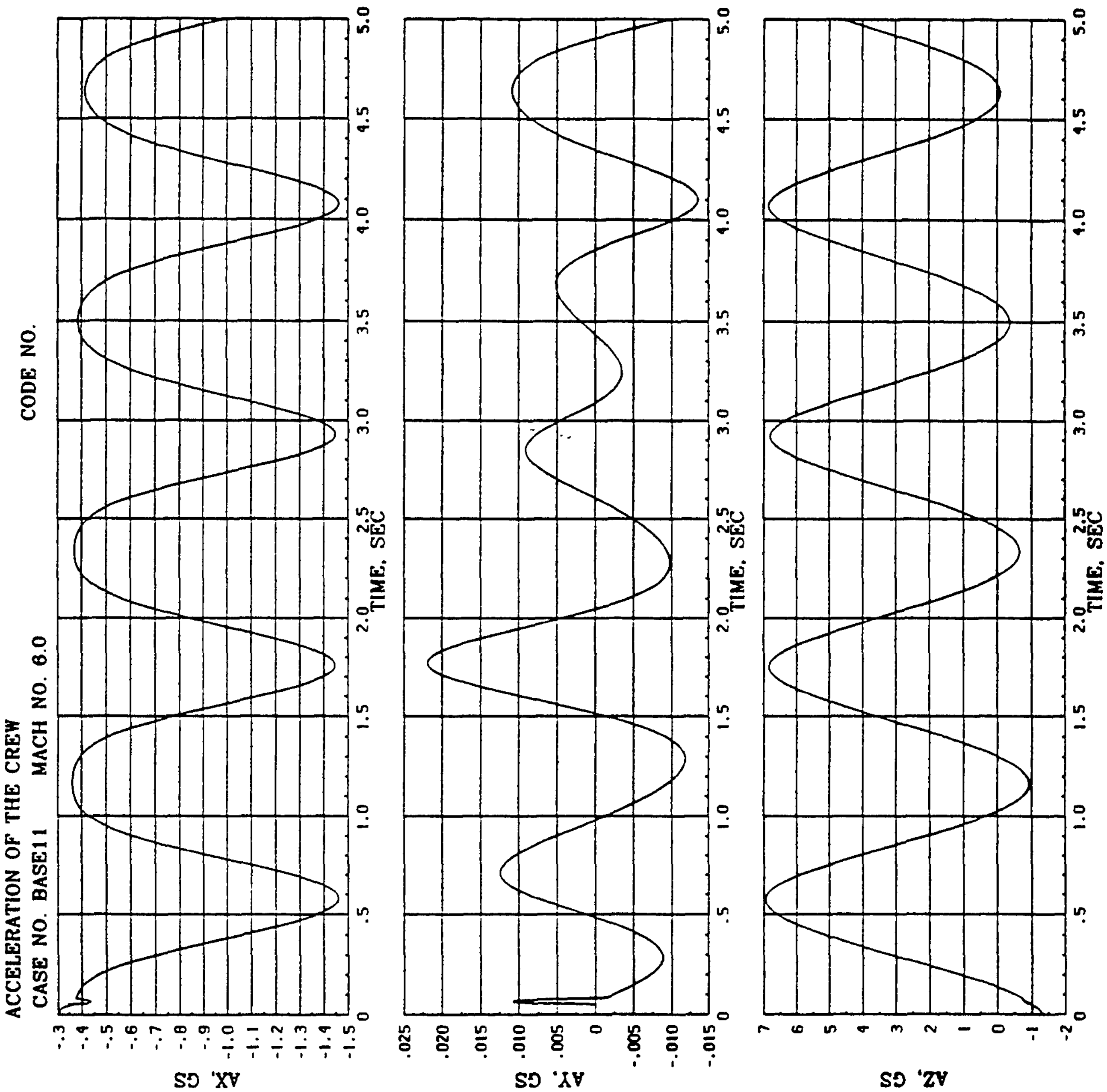


EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE7 MACH NO. 6.0
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC

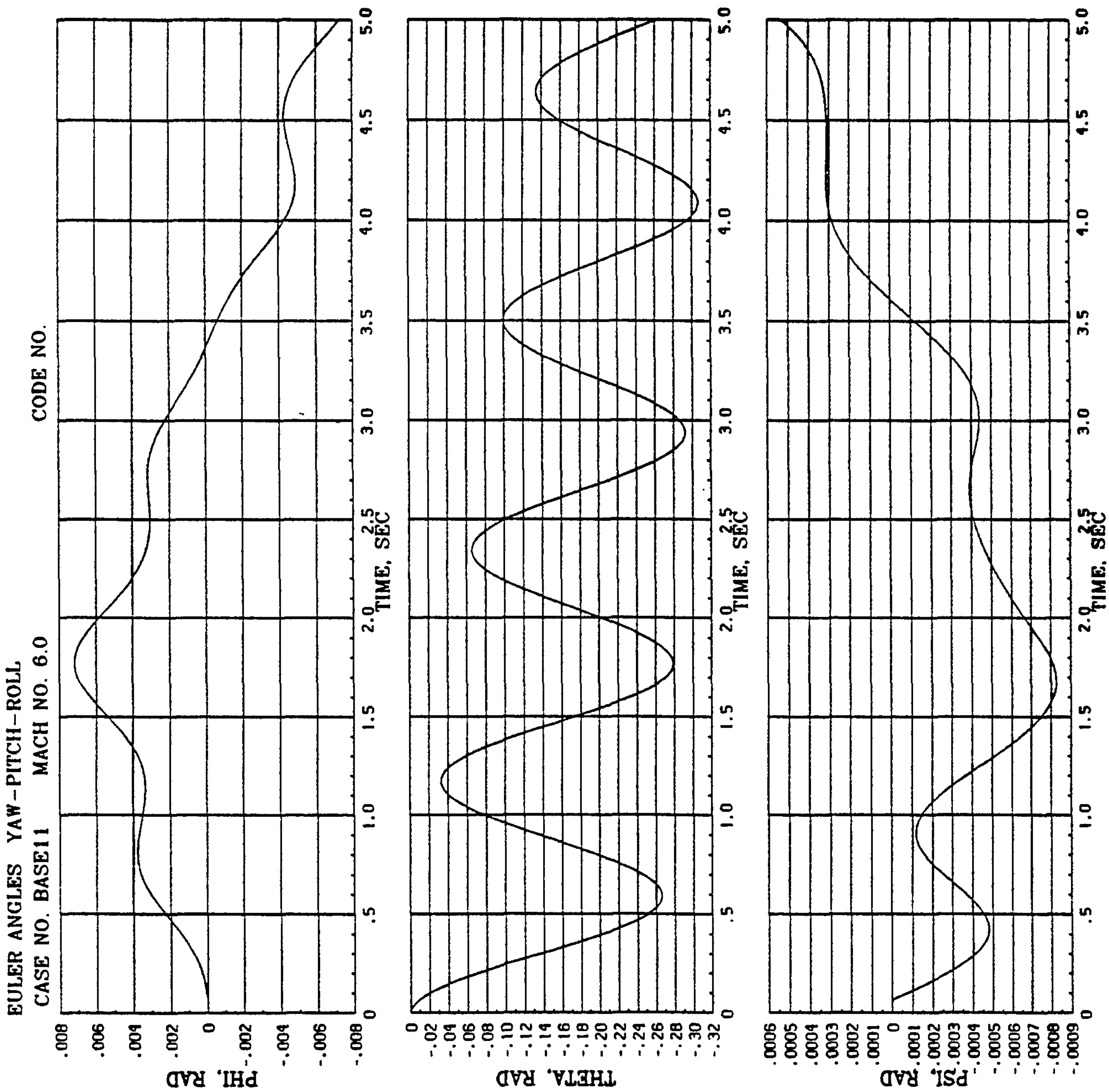

FORCES ON FOREBODY
CASE NO. BASE7
MACH NO. 6.0
CODE NO.
FX, lb*E03
TIME, SEC
FY, lb*E03
TIME, SEC
FZ, lb*E03
TIME


CASE NO. BASE11
MACH NO. 6.0
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

Case 9

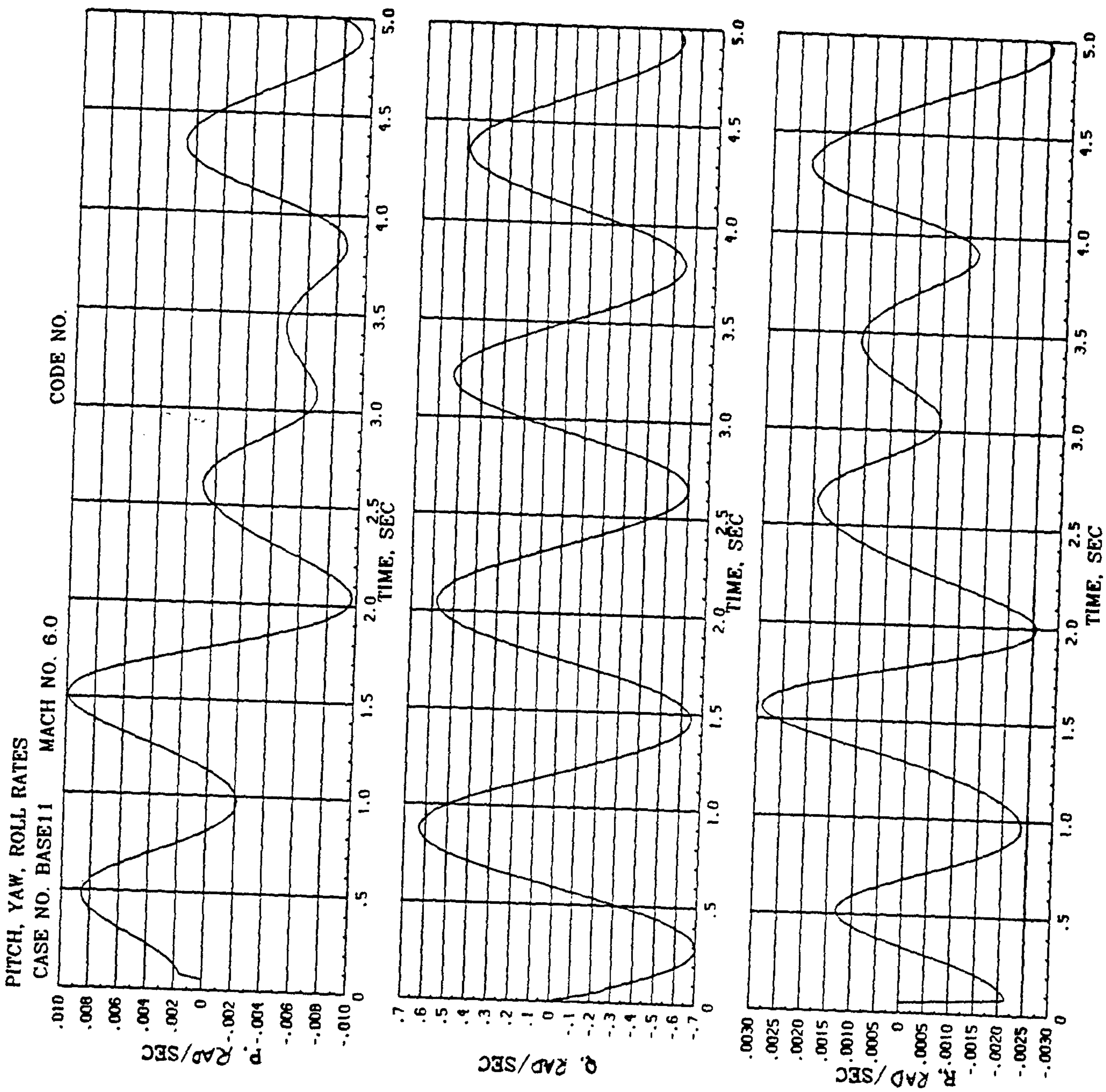

ACCELERATION OF THE CREW
CASE NO. BASE11
MACH NO. 6.0
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 9



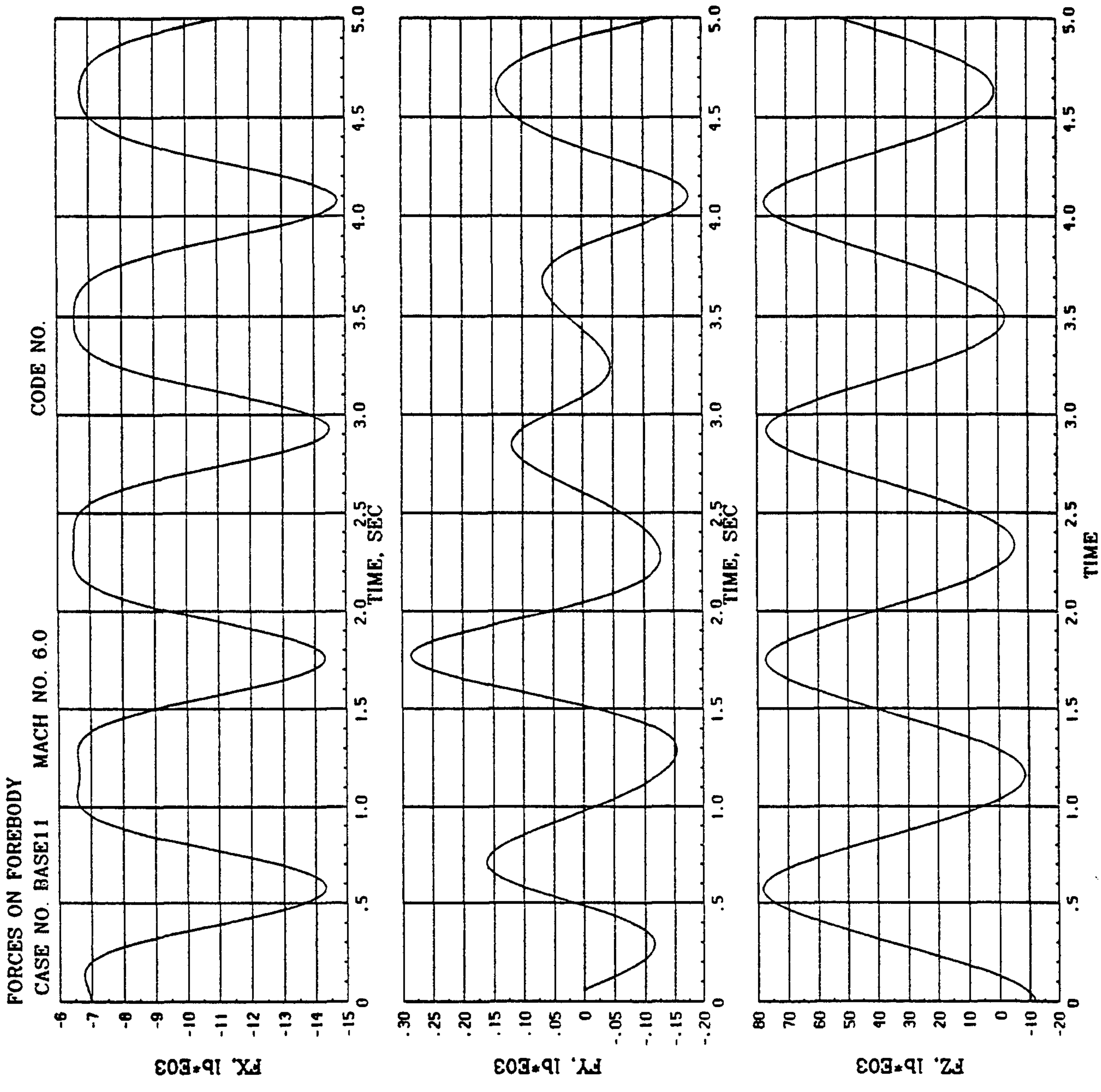
EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE11 MACH NO. 6.0
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
TIME, SEC
TIME, SEC

Case 9



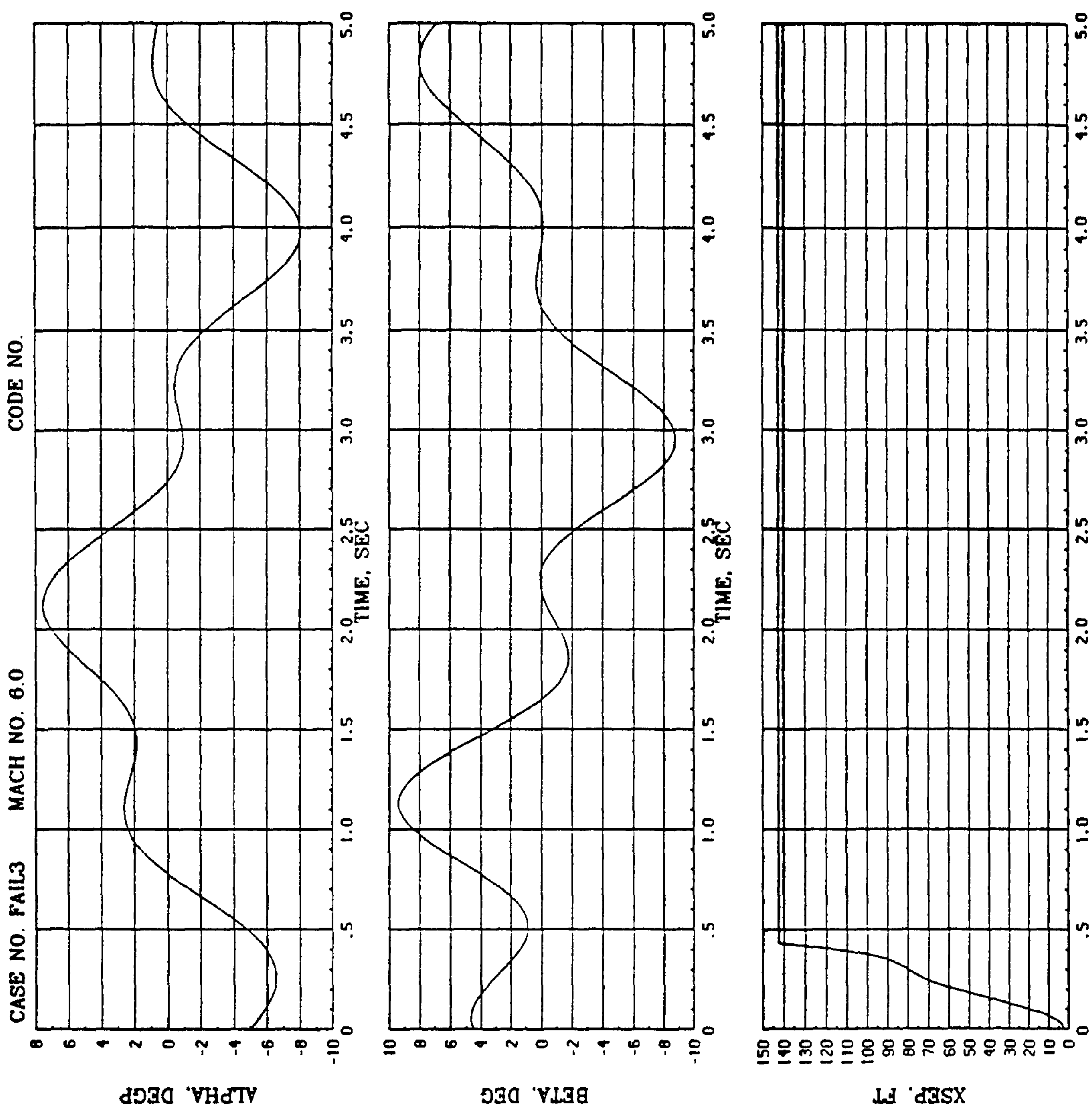
PITCH, YAW, ROLL RATES
CASE NO. BASE11
MACH NO. 6.0
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC

Case 9



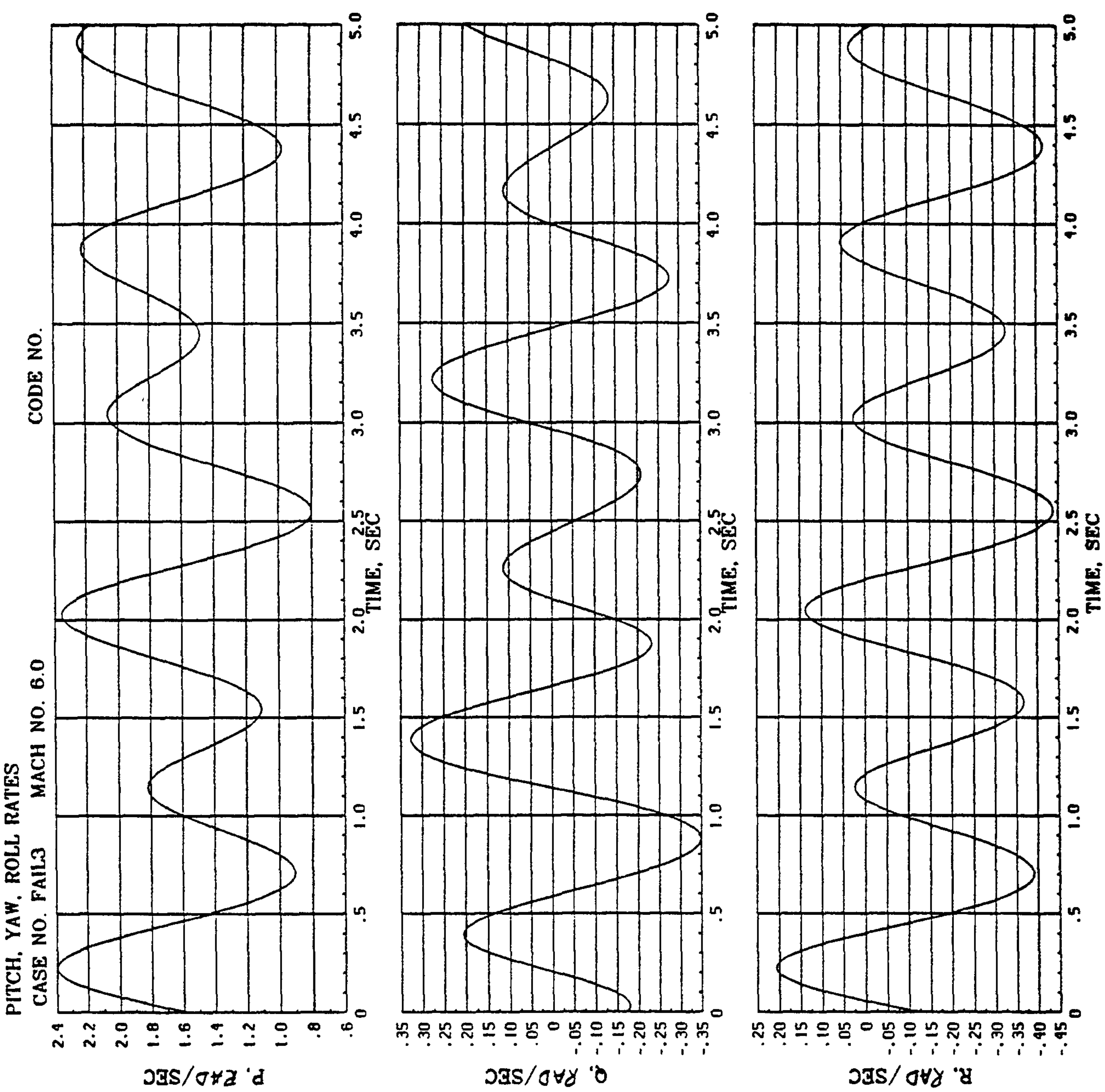
FORCES ON FOREBODY
CASE NO. BASE11
MACH NO. 6.0
CODE NO.
FX, lb*E03
TIME, SEC
FY, lb*E03
TIME, SEC
FZ, lb*E03
TIME

Case 10



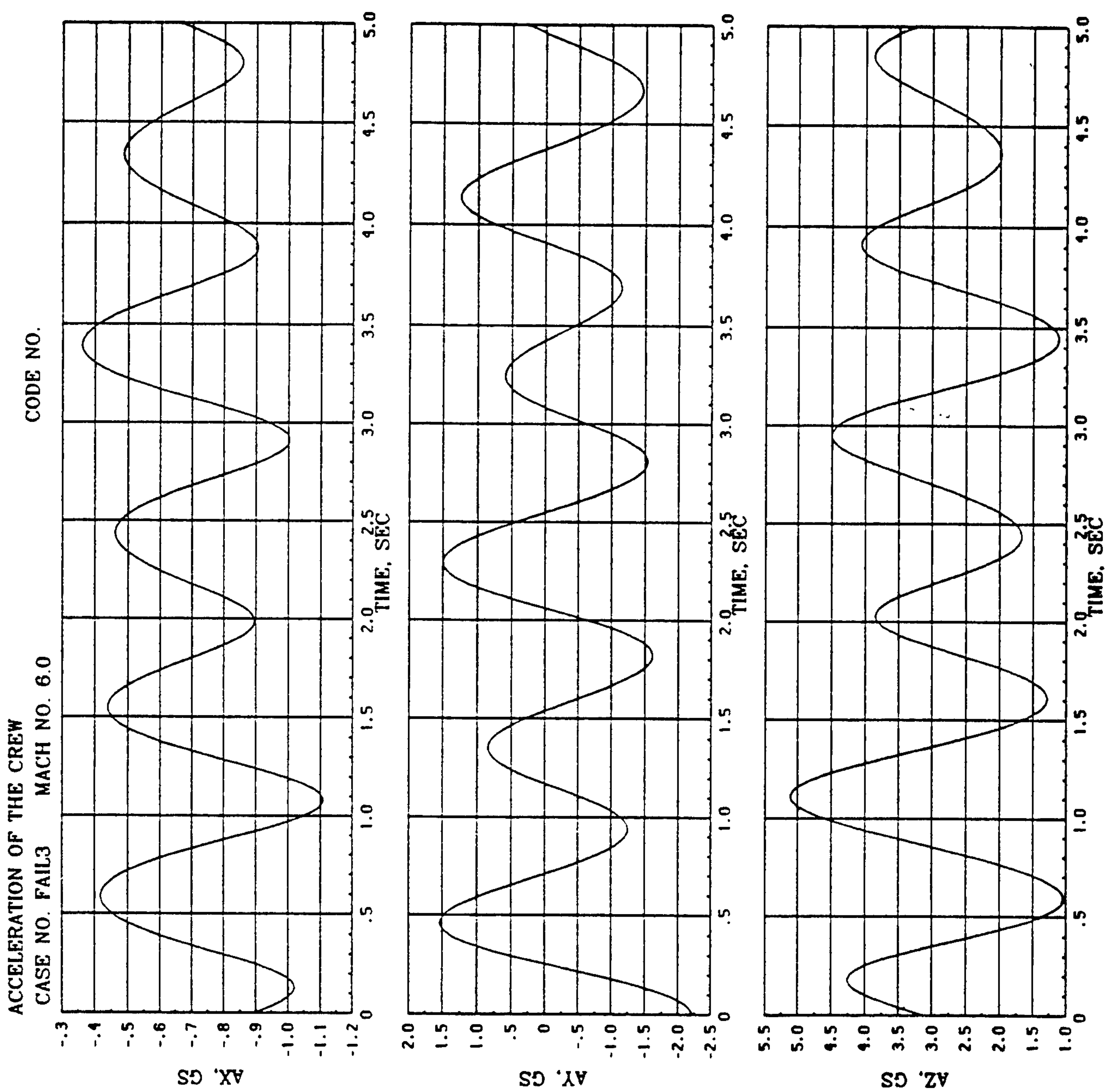
CASE NO. FAIL3
MACH NO. 6.0
CODE NO.
ALPHA, DEGP
BETA, DEG
XSEP, FT
TIME, SEC
TIME, SEC
TIME

Case 10

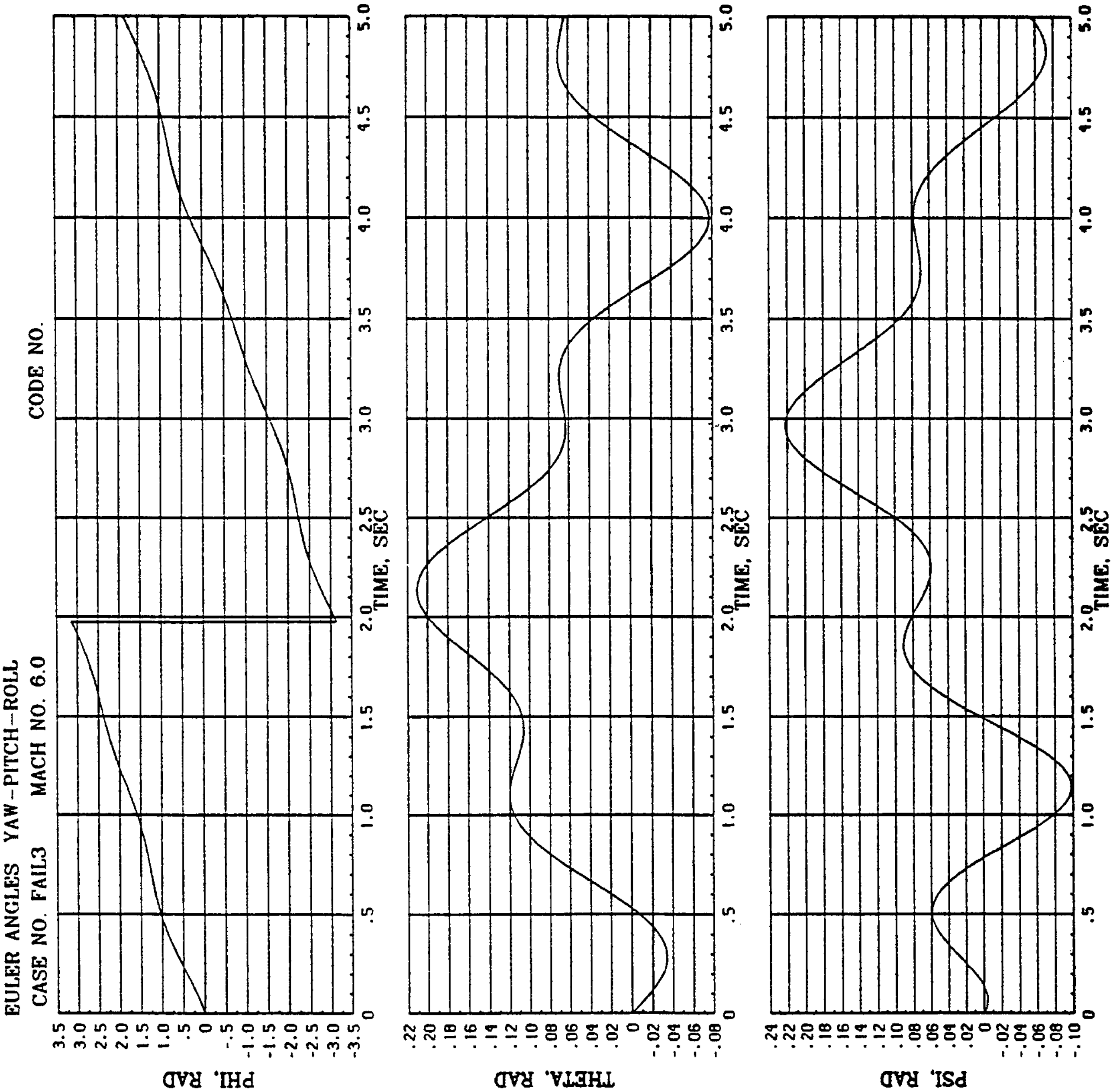


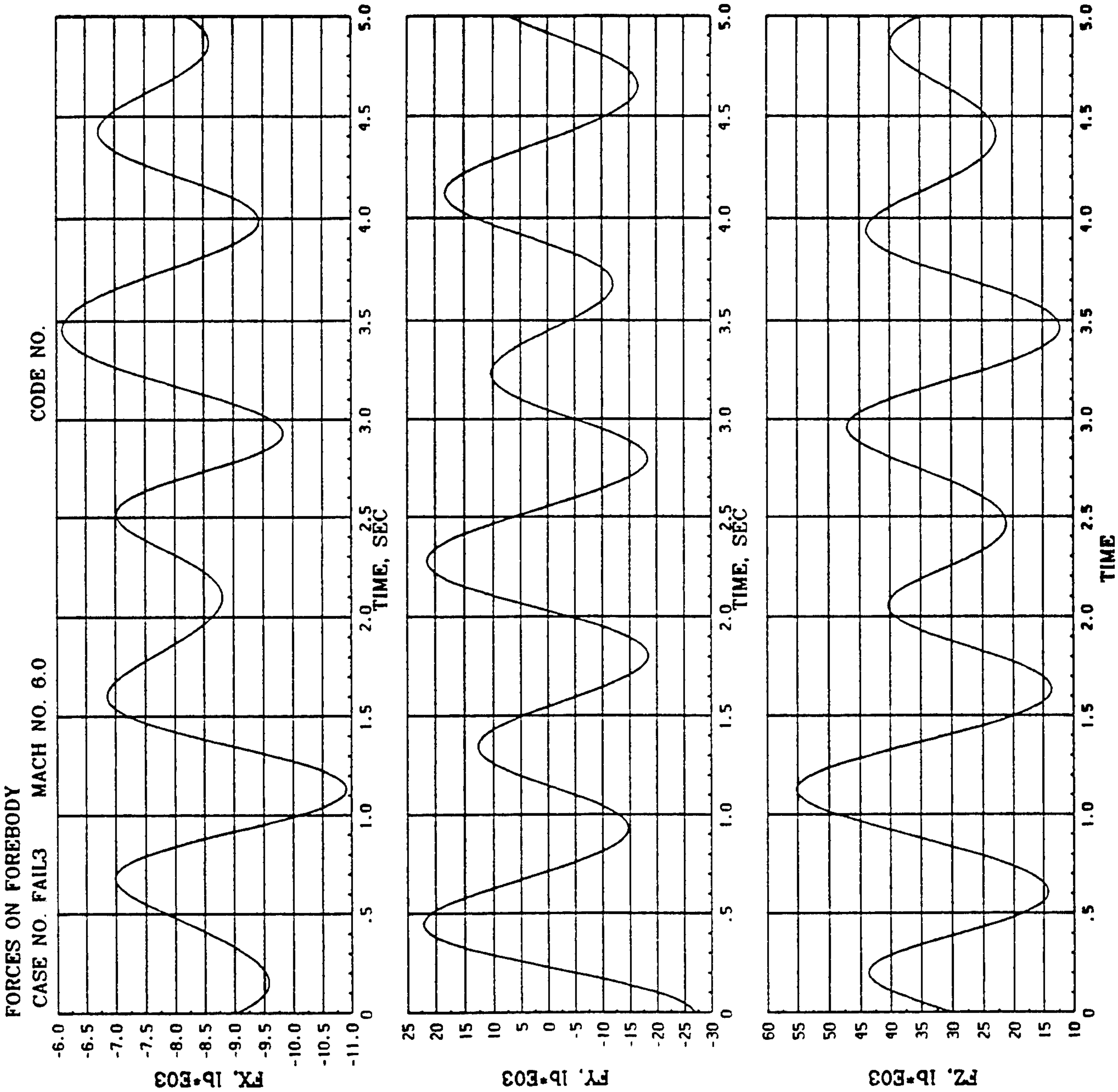
PITCH, YAW, ROLL RATES
CASE NO. FAIL3
MACH NO. 6.0
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC
TIME, SEC
TIME, SEC

Case 10

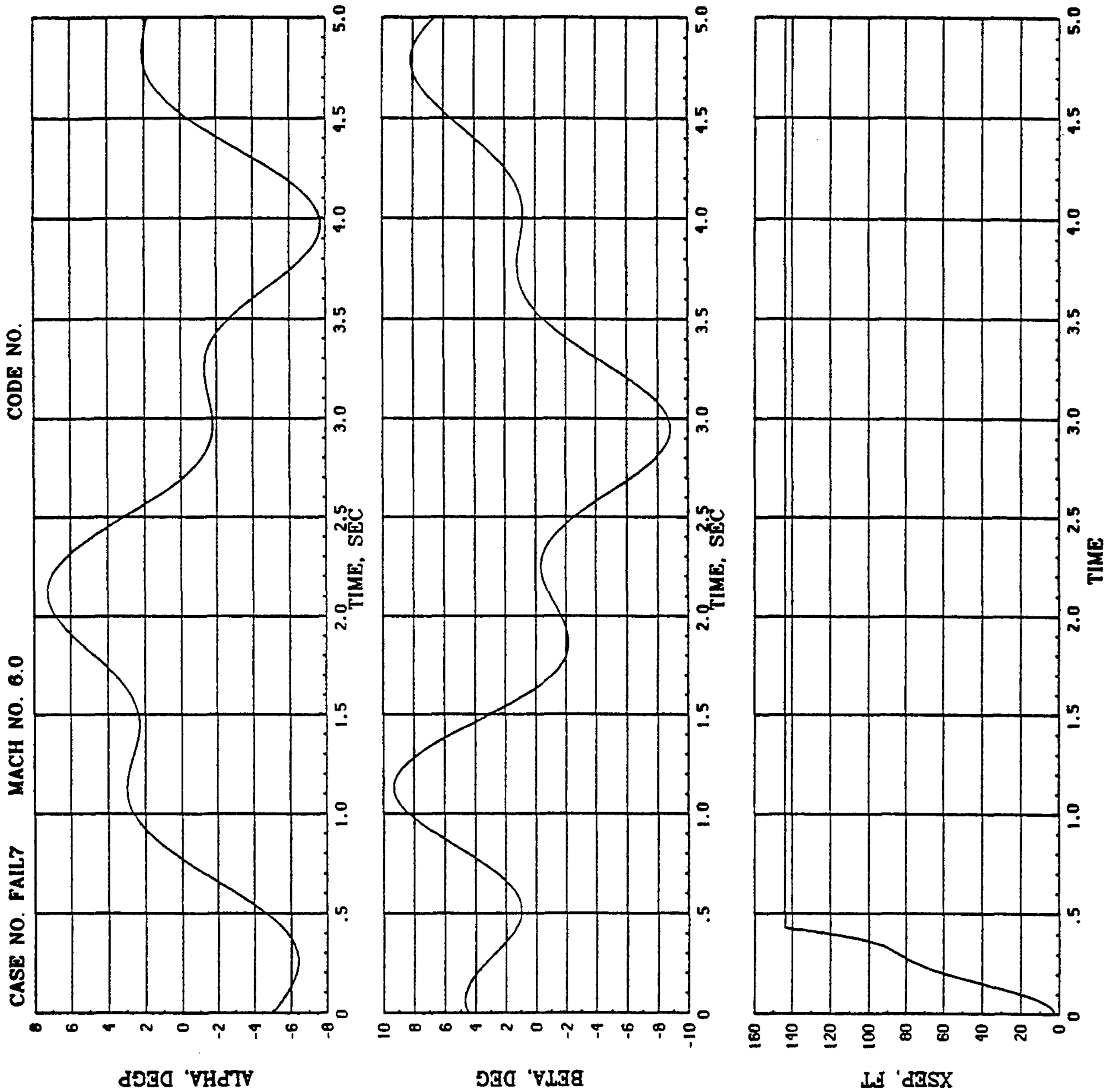

ACCELERATION OF THE CREW
CASE NO. FAIL3
MACH NO. 6.0
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
TIME, SEC
TIME, SEC

Case 10

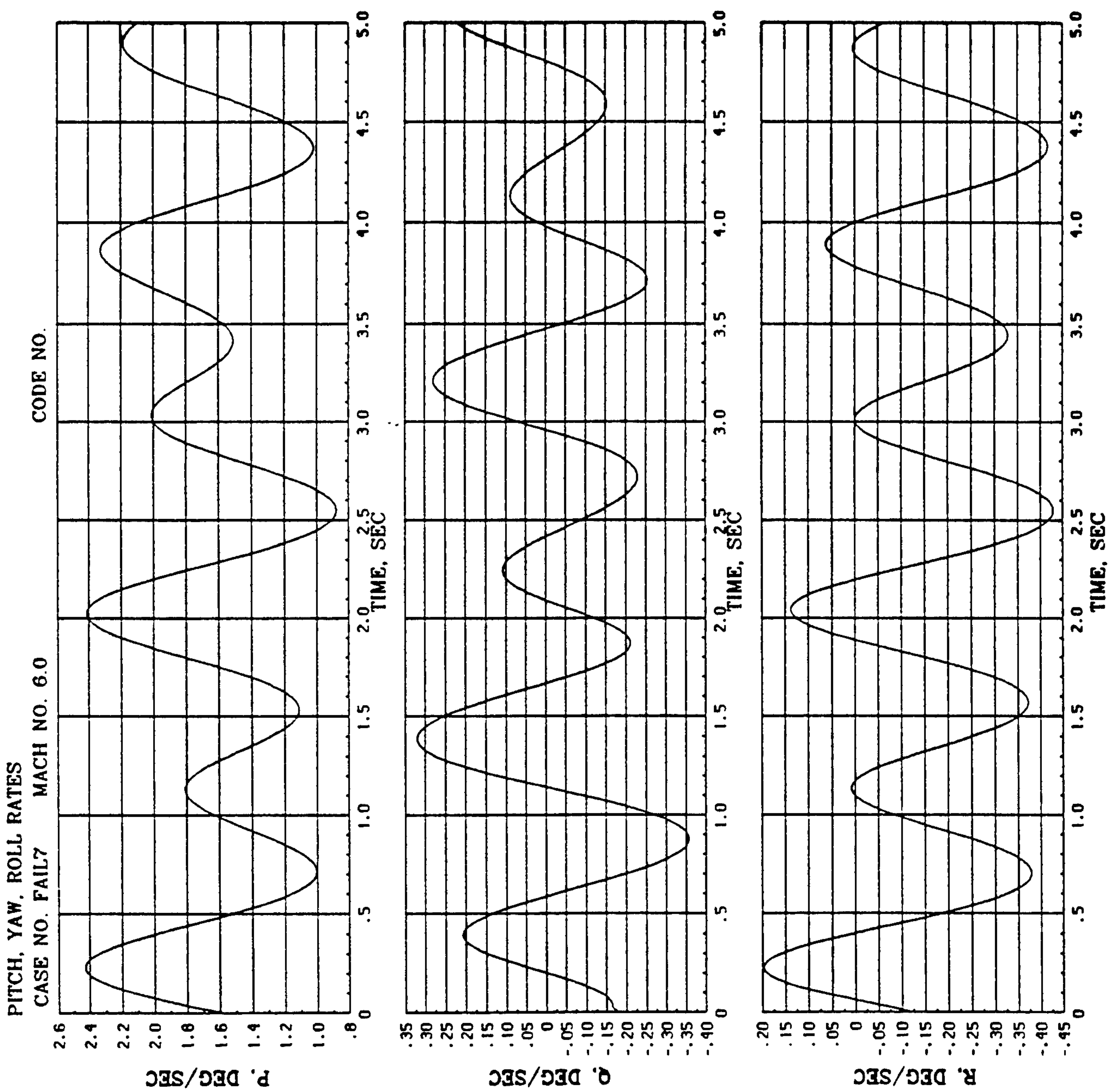

EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL3 MACH NO. 6.0
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC


FORCES ON FOREBODY
CASE NO. FAIL3
MACH NO. 6.0
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

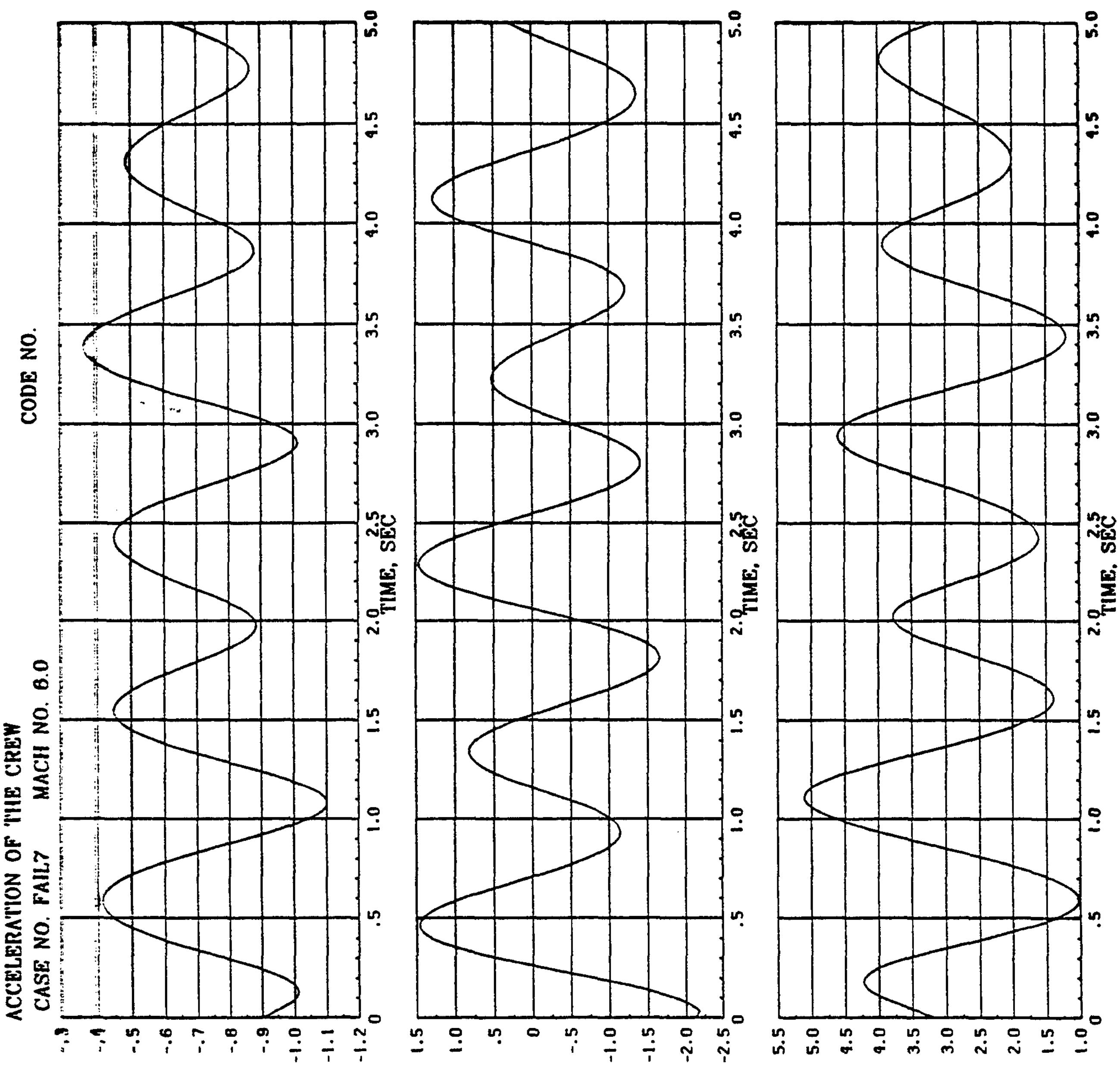
Case 11



CASE NO. FAIL7
MACH NO. 6.0
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

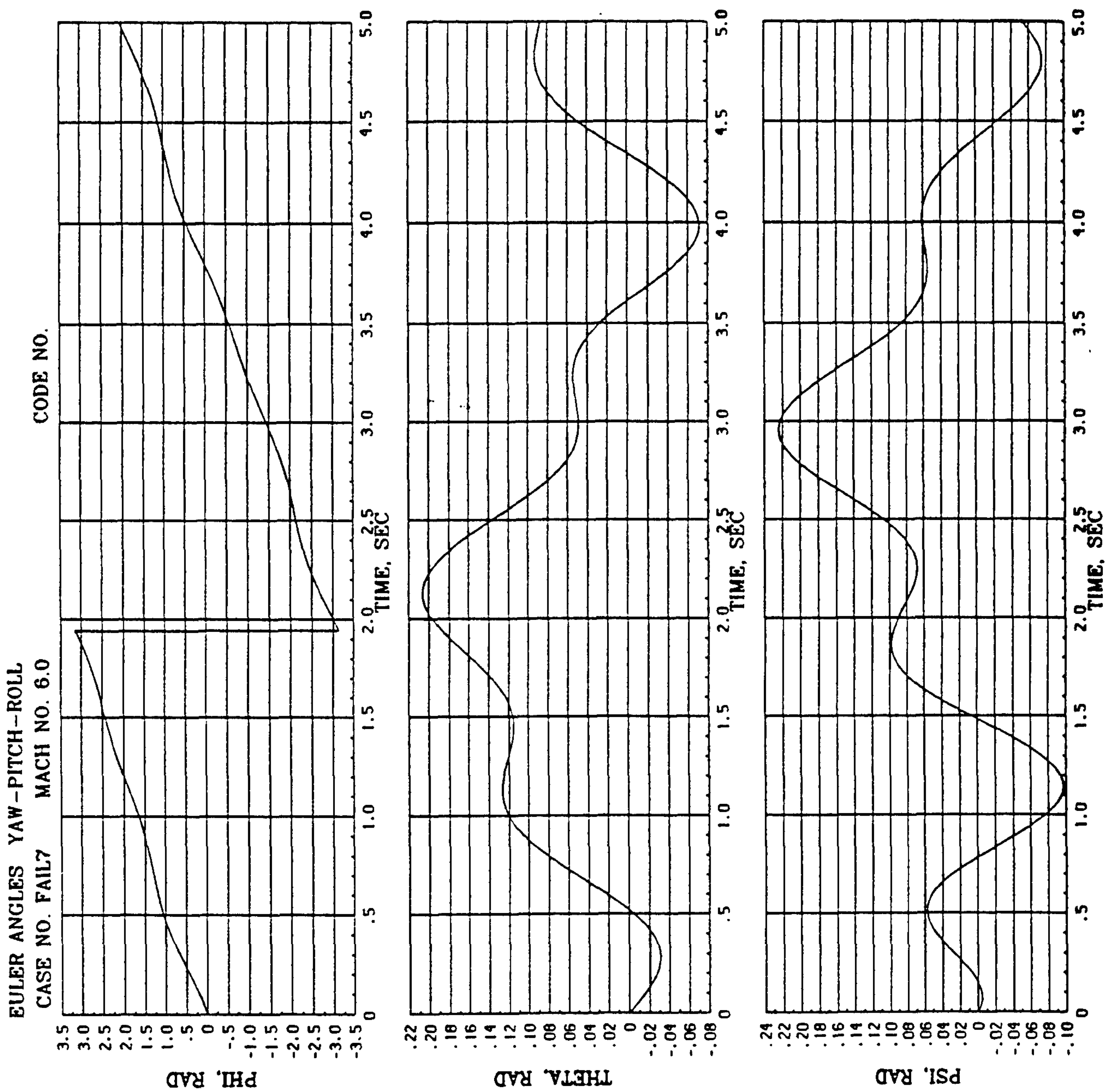

PITCH, YAW, ROLL RATES
CASE NO. FAIL7
MACH NO. 6.0
CODE NO.
P, DEG/SEC
Q, DEG/SEC
R, DEG/SEC
TIME, SEC
TIME, SEC
TIME, SEC

Case 11



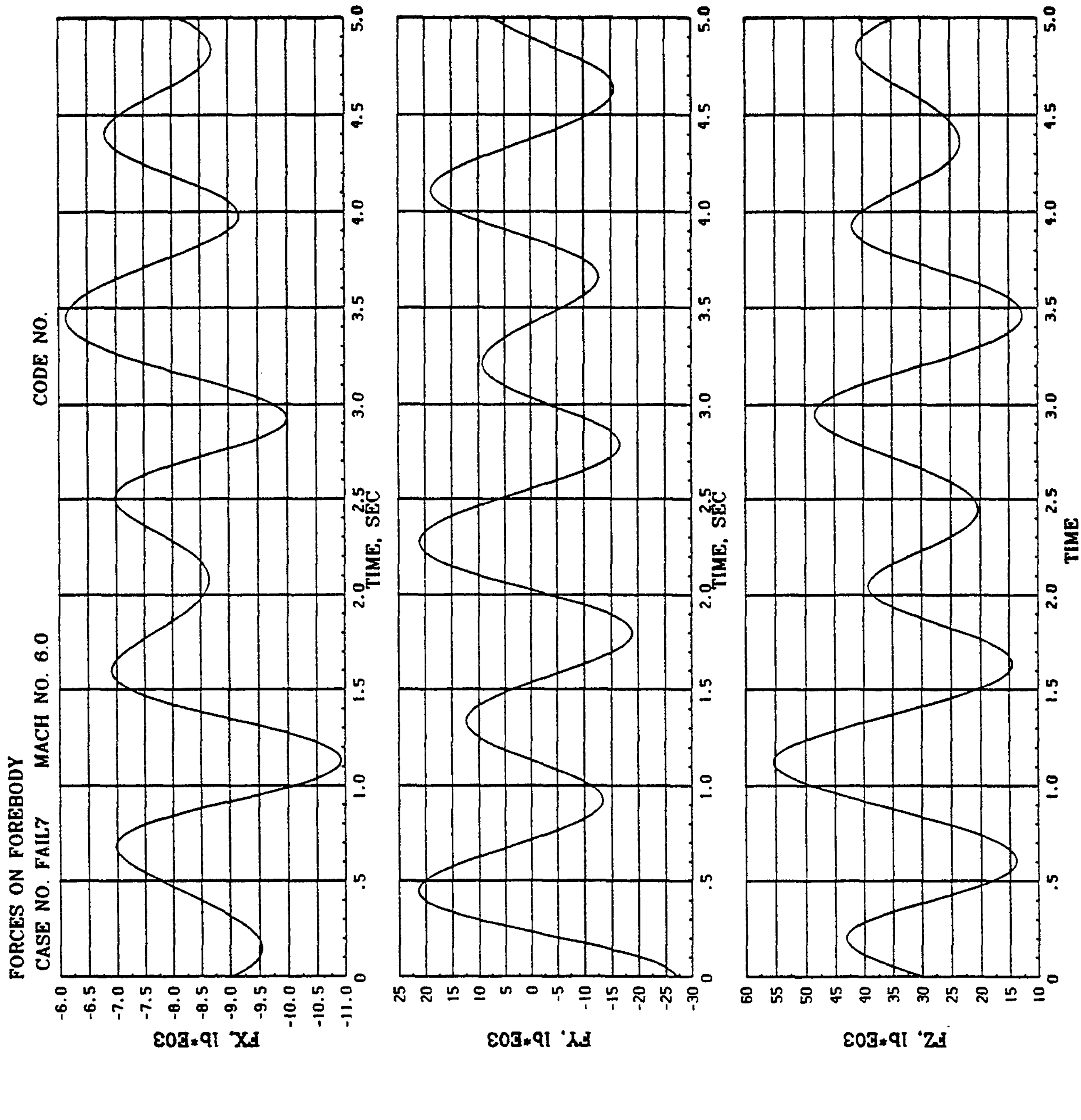
ACCELERATION OF THE CREW
CASE NO. FAIL7 MACH NO. 6.0
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 11

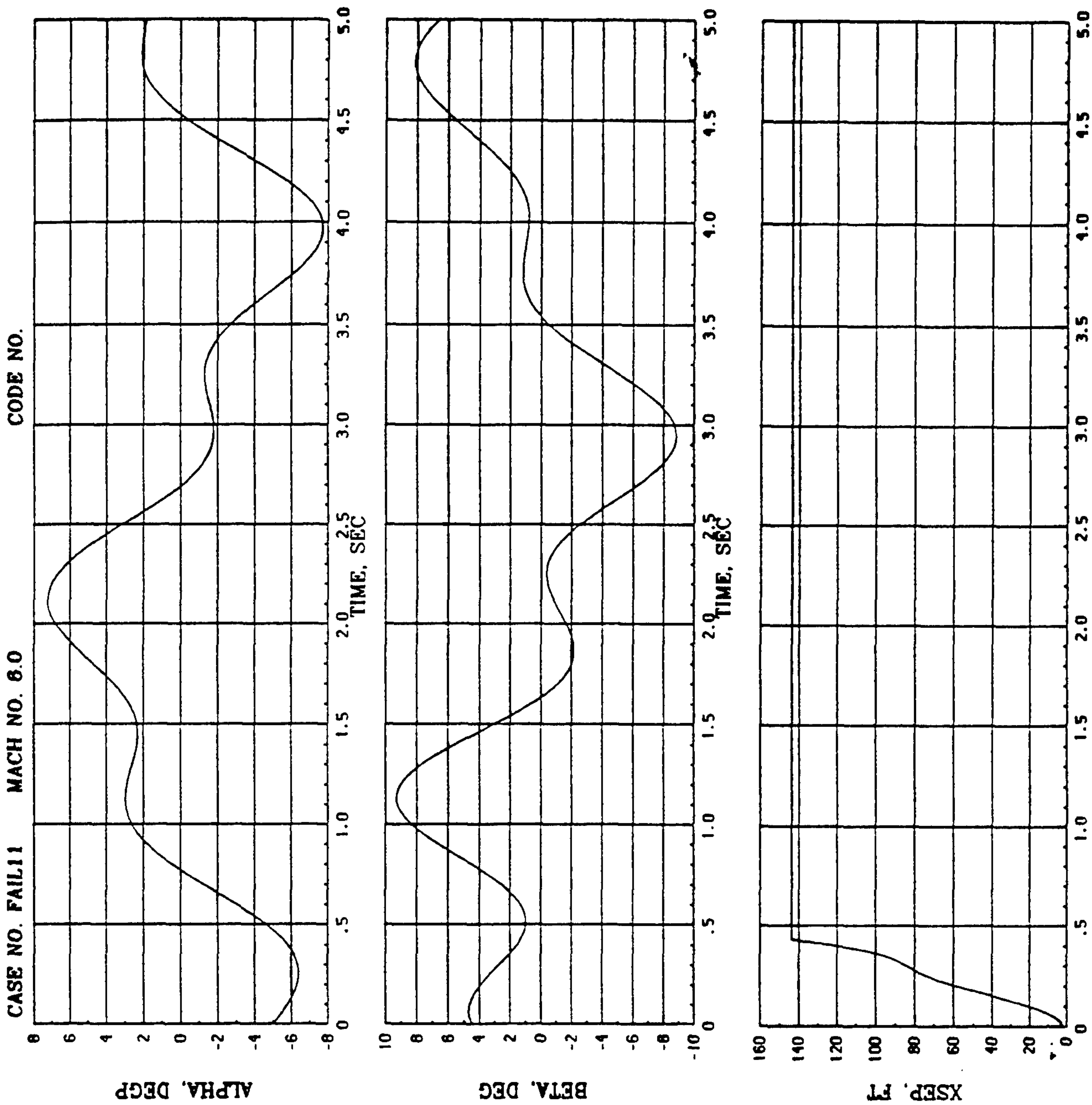


EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL7 MACH NO. 6.0
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC

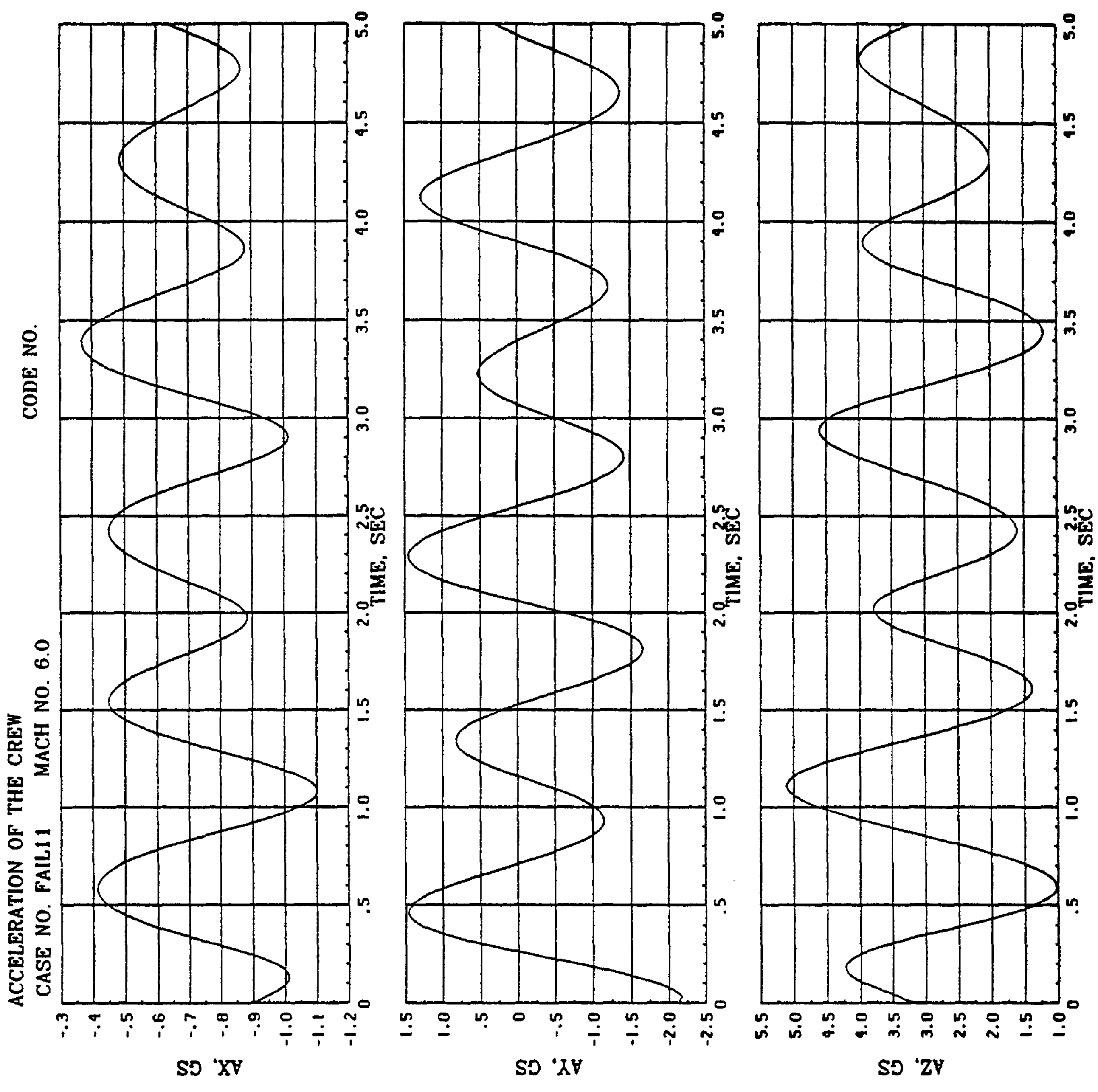
Case 11


FORCES ON FOREBODY
CASE NO. FAIL7
MACH NO. 6.0
CODE NO.
TIME, SEC
TIME, SEC
TIME
FX, lb*E03
FY, lb*E03
FZ, lb*E03

Case 12


CASE NO. FAIL11
MACH NO. 6.0
CODE NO.
ALPHA, DEGP
BETA, DEG
XSEP, FT
TIME, SEC
TIME, SEC
TIME

Case 12


ACCELERATION OF THE CREW
CASE NO. FAIL11
MACH NO. 6.0
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
-.3
-.4
-.5
-.6
-.7
-.8
-.9
-1.0
-1.1
-1.2
1.5
1.0
.5
0
-.5
-1.0
-1.5
-2.0
-2.5
5.5
5.0
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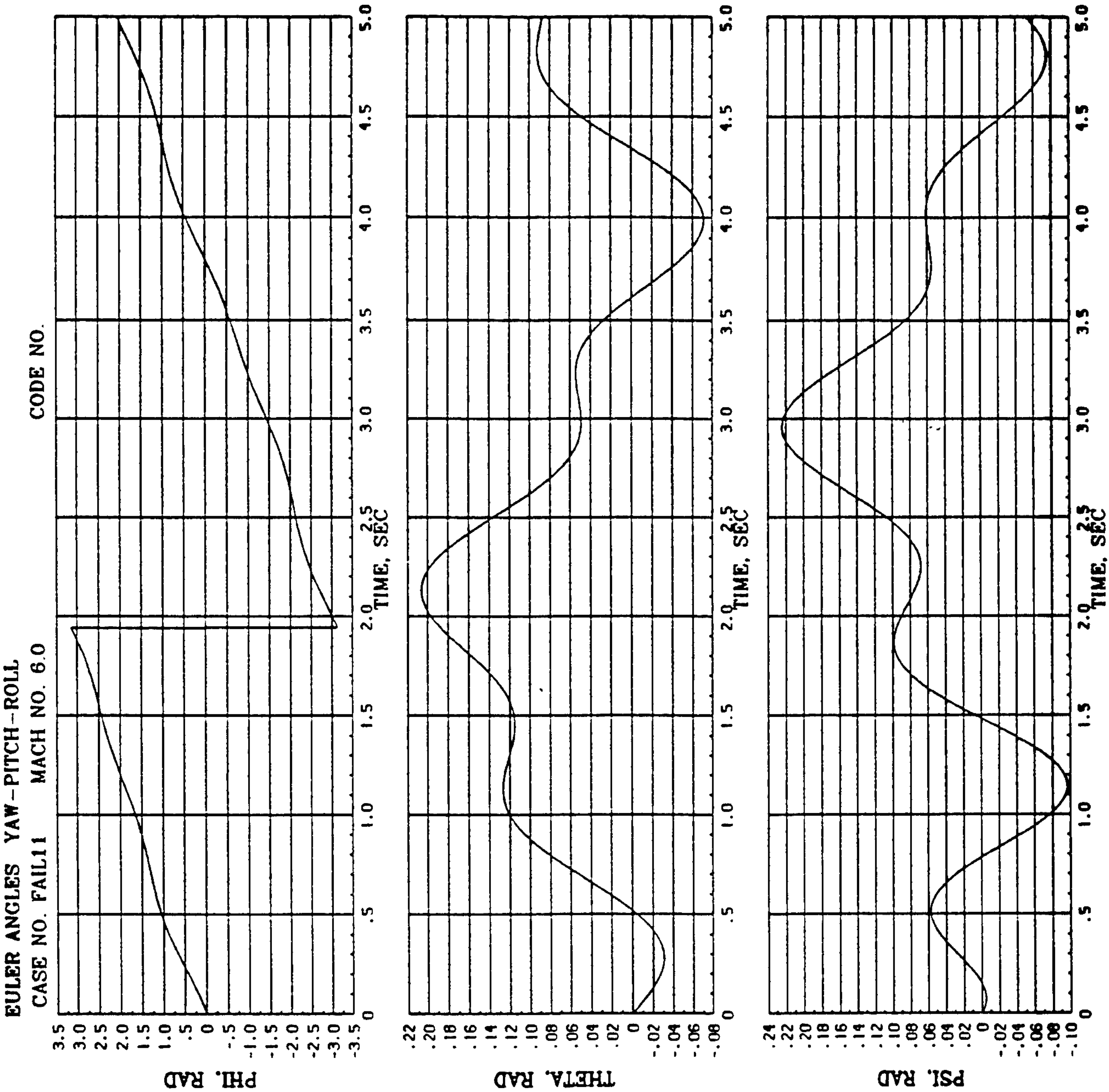
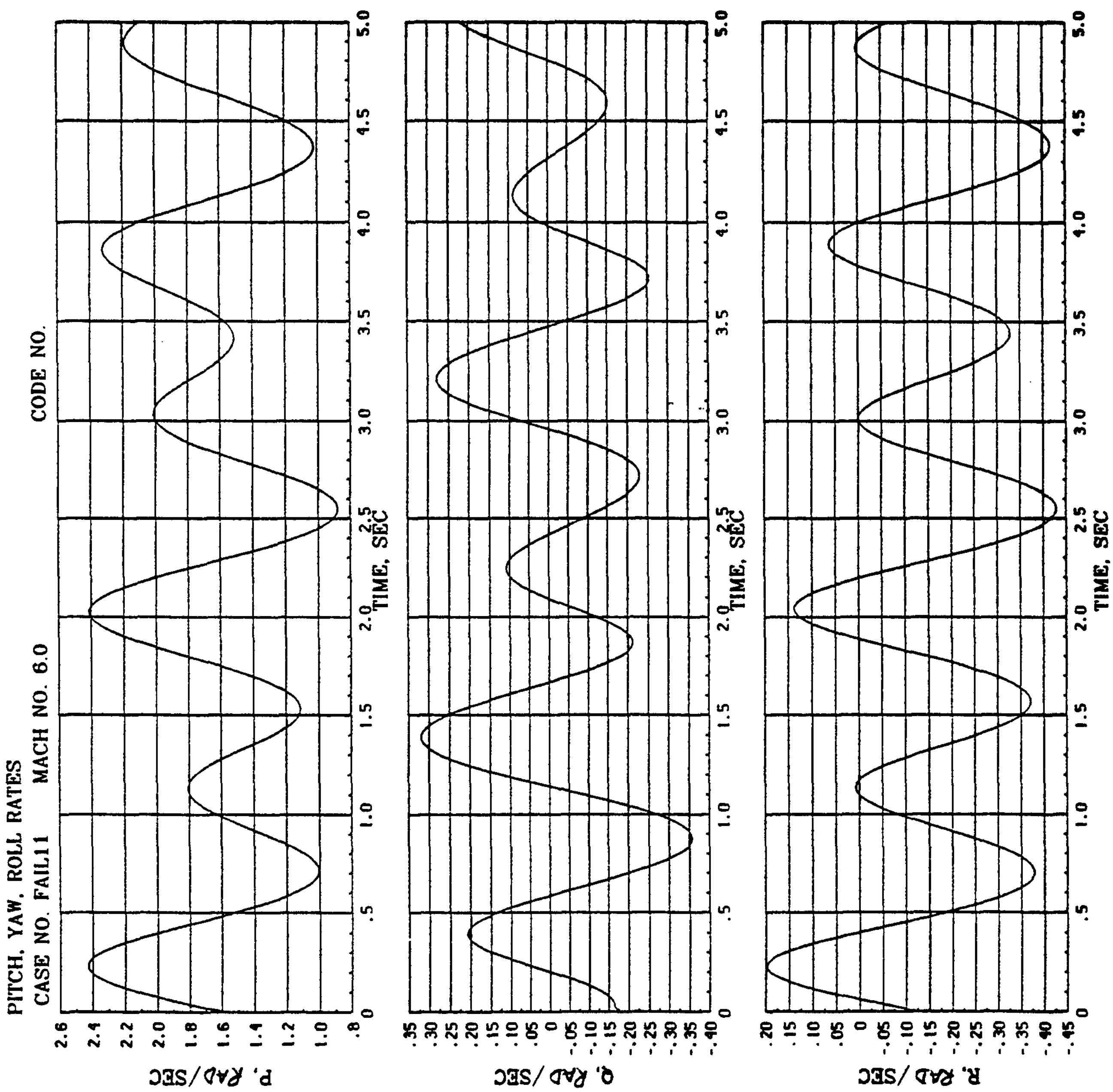
4.0
3.5
3.0
2.5
2.0
1.5
1.0

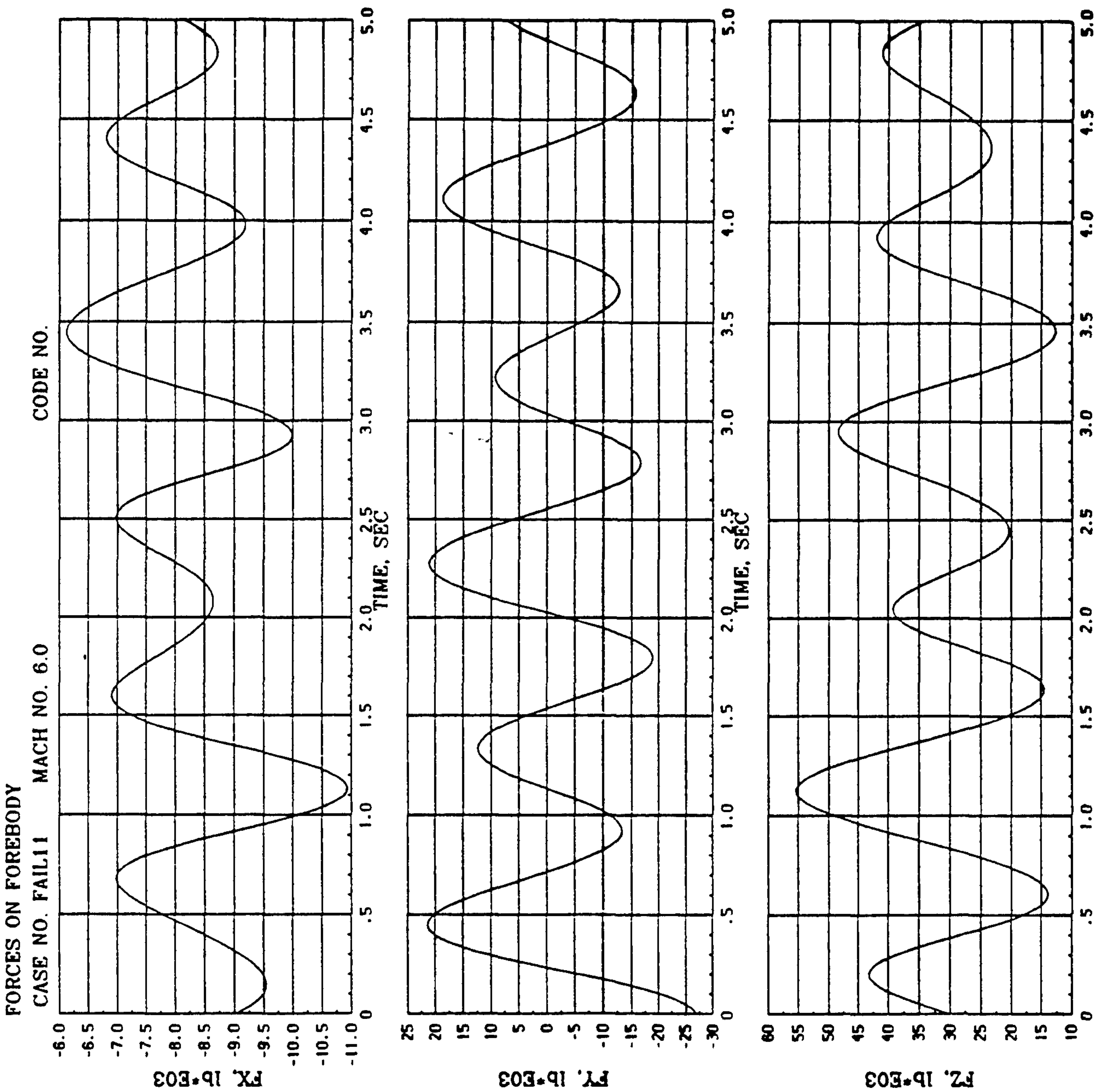
Case 12


EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL11
MACH NO. 6.0
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC

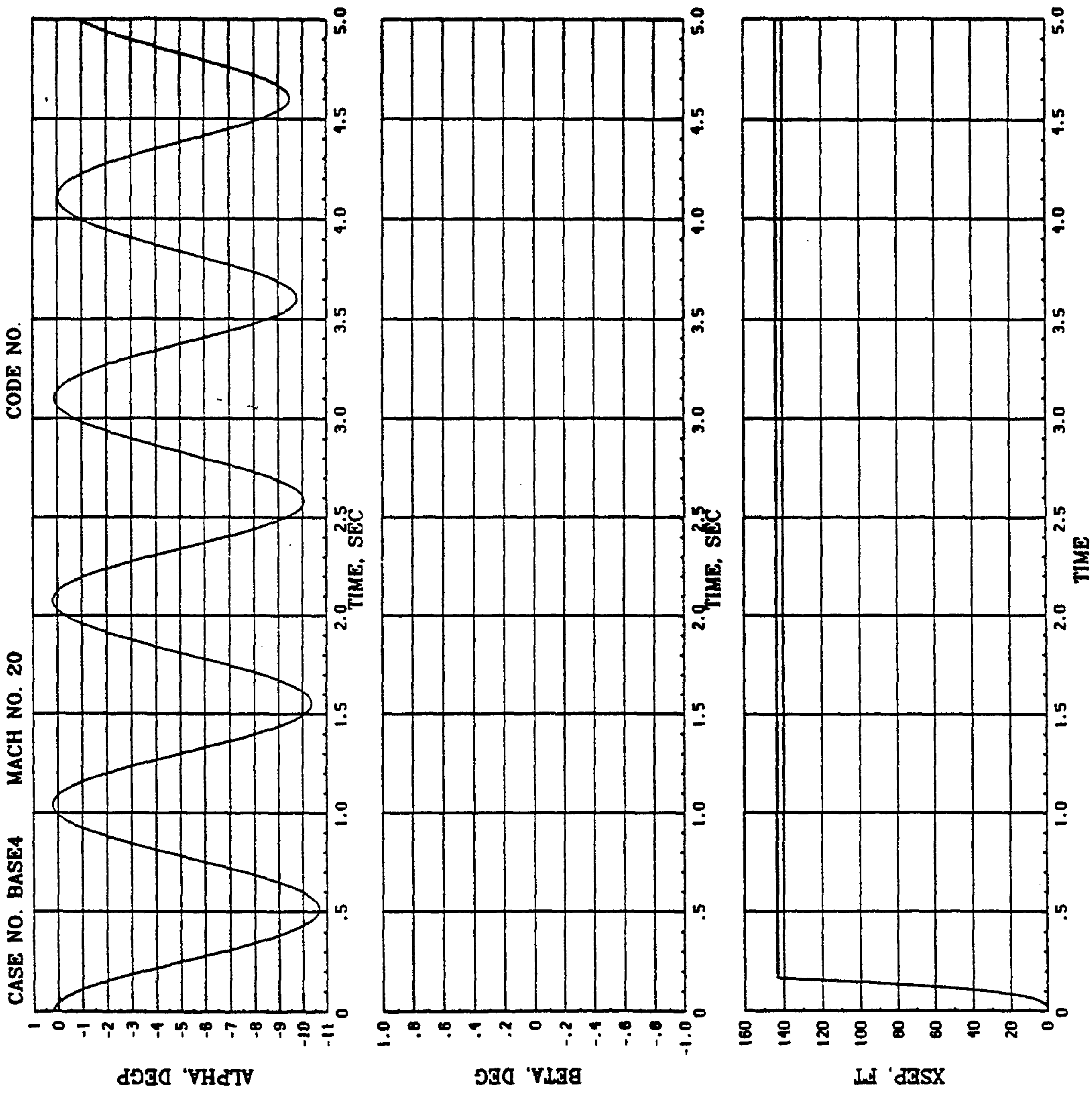
Case 12


PITCH, YAW, ROLL RATES
CASE NO. FAIL11
MACH NO. 6.0
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC
TIME, SEC
TIME, SEC

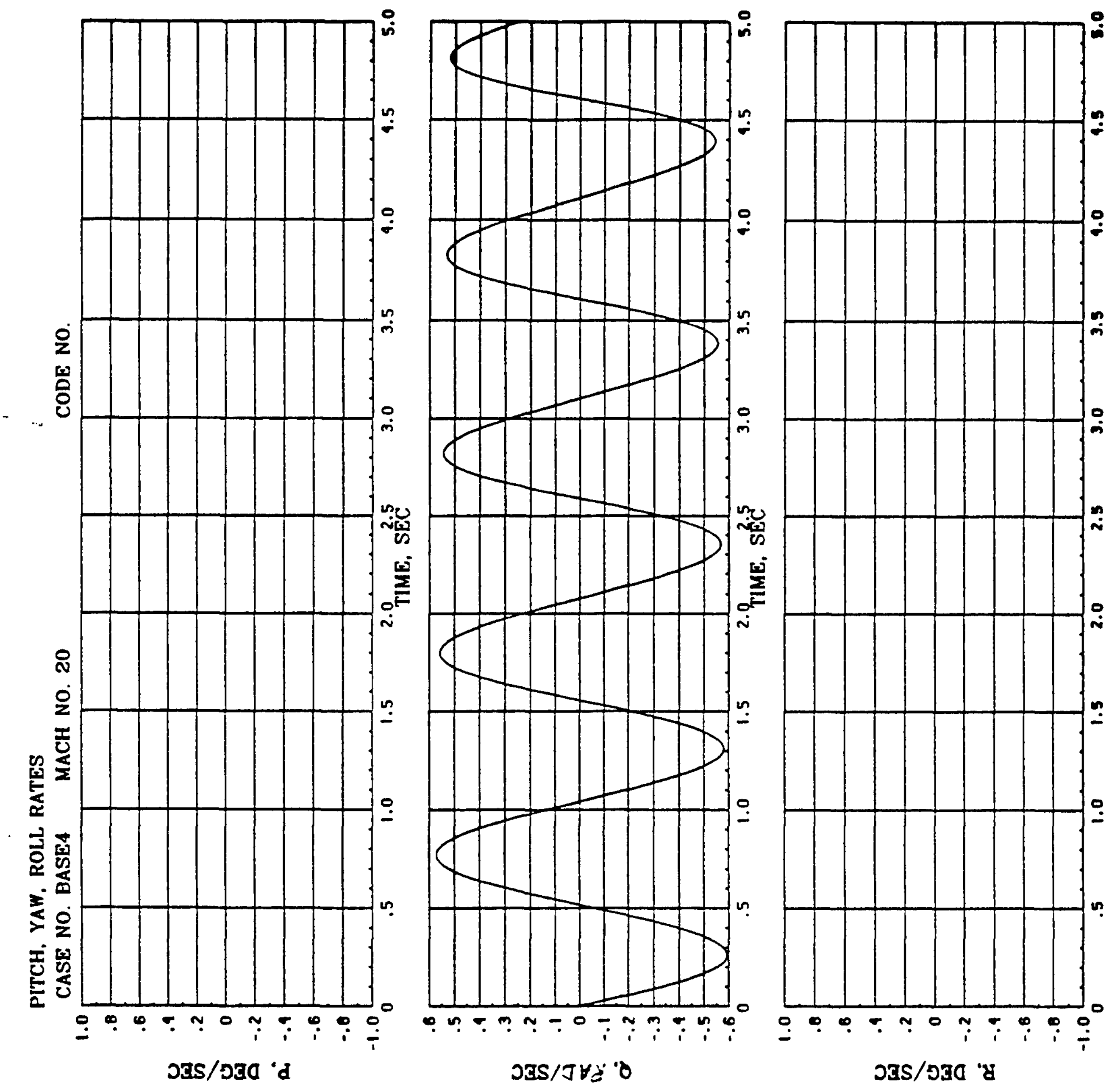
Case 12


FORCES ON FOREBODY
CASE NO. FAIL11
MACH NO. 6.0
CODE NO.
TIME, SEC
TIME, SEC
TIME
FX, lb*E03
FY, lb*E03
FZ, lb*E03

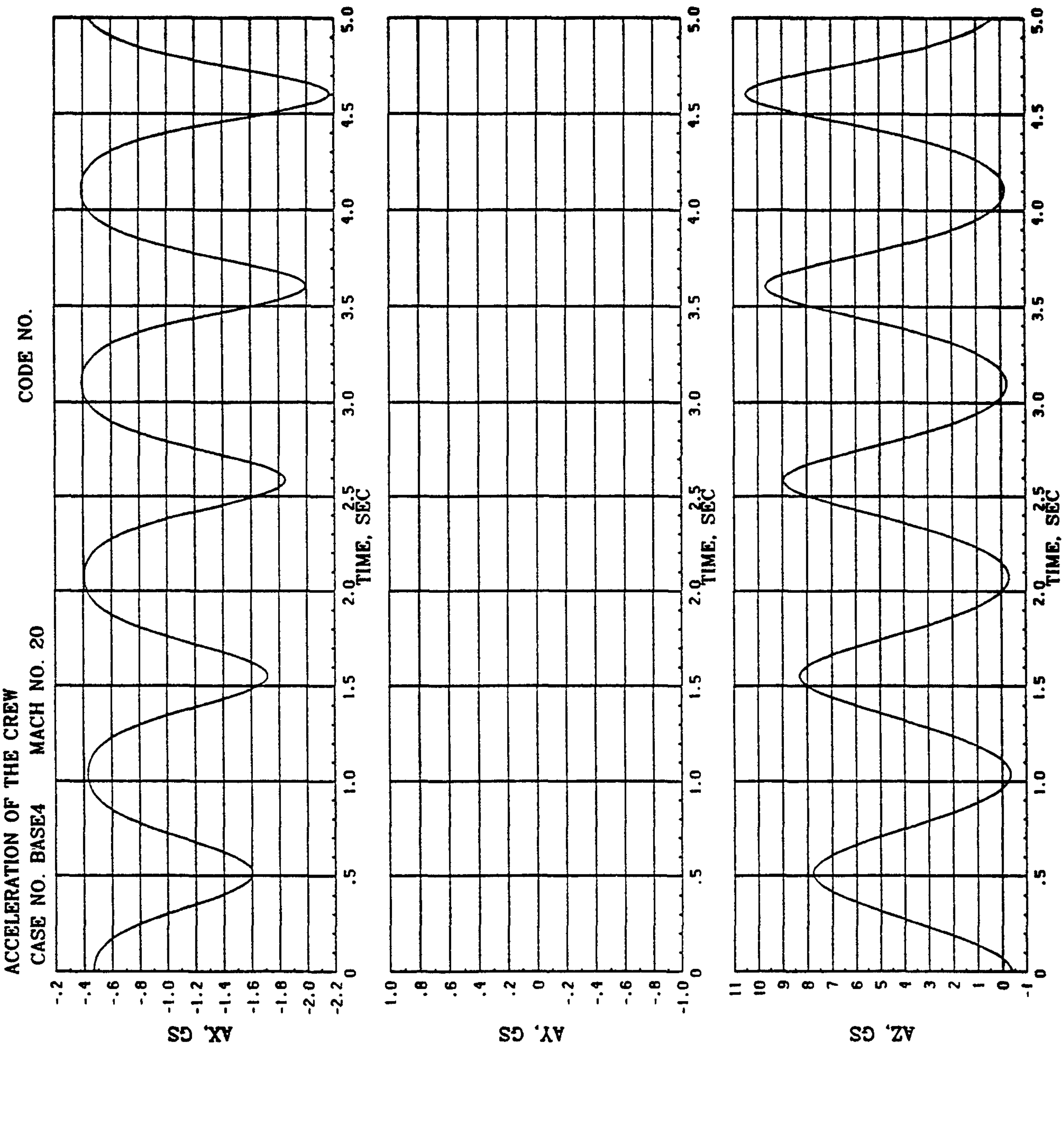
Case 13


CASE NO. BASE4
MACH NO. 20
CODE NO.
ALPHA, DEGP
BETA, DEG
XSEP, FT
TIME, SEC
TIME, SEC
TIME

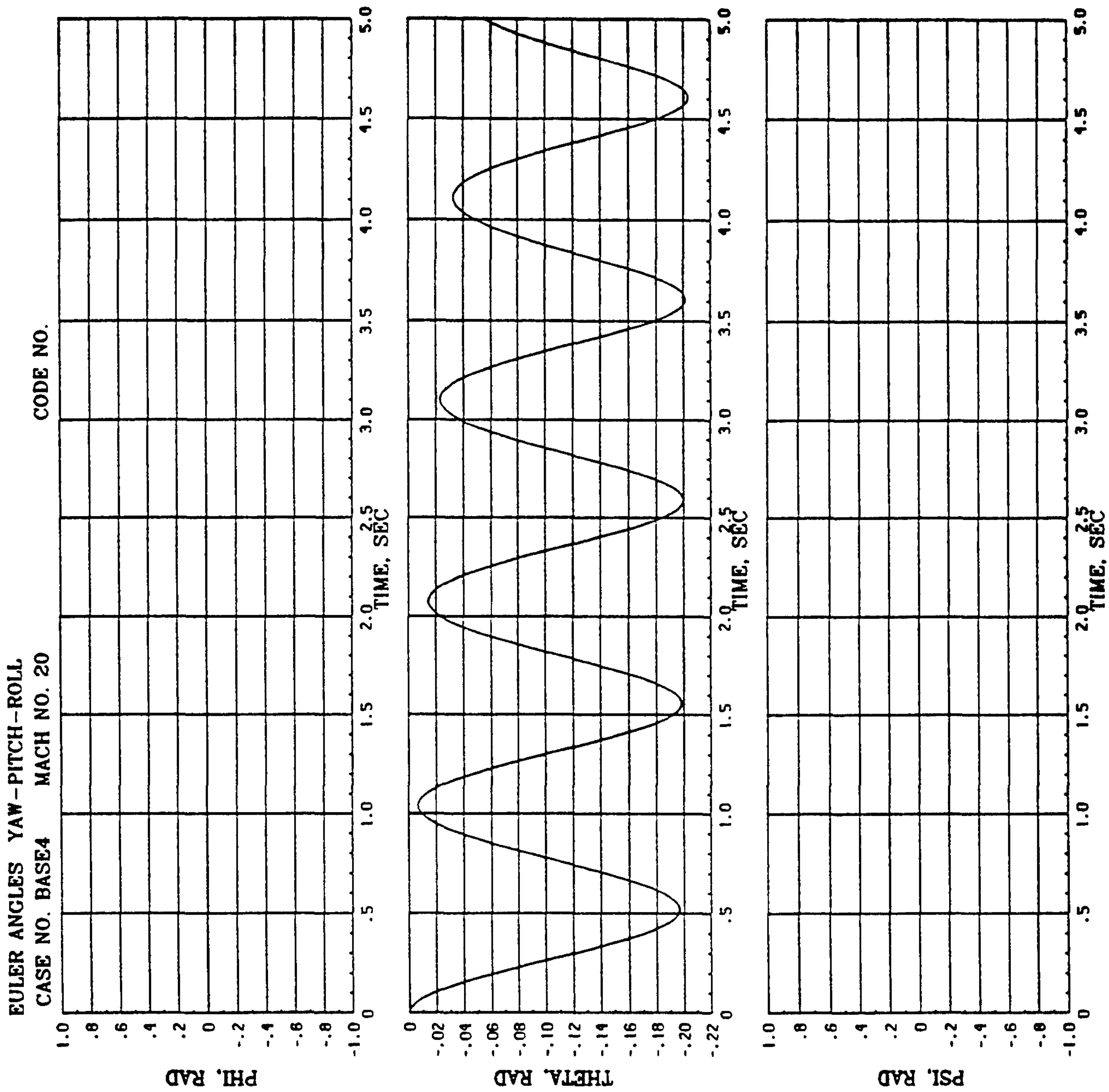
Case 13


PITCH, YAW, ROLL RATES
CASE NO. BASE4
MACH NO. 20
CODE NO.
P, DEG/SEC
Q, RAD/SEC
R, DEG/SEC
TIME, SEC

Case 13


ACCELERATION OF THE CREW
CASE NO. BASE4
MACH NO. 20
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
TIME, SEC
TIME, SEC

Case 13


EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE4
MACH NO. 20
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
1.0
.8
.6
.4
.2
0
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-.4
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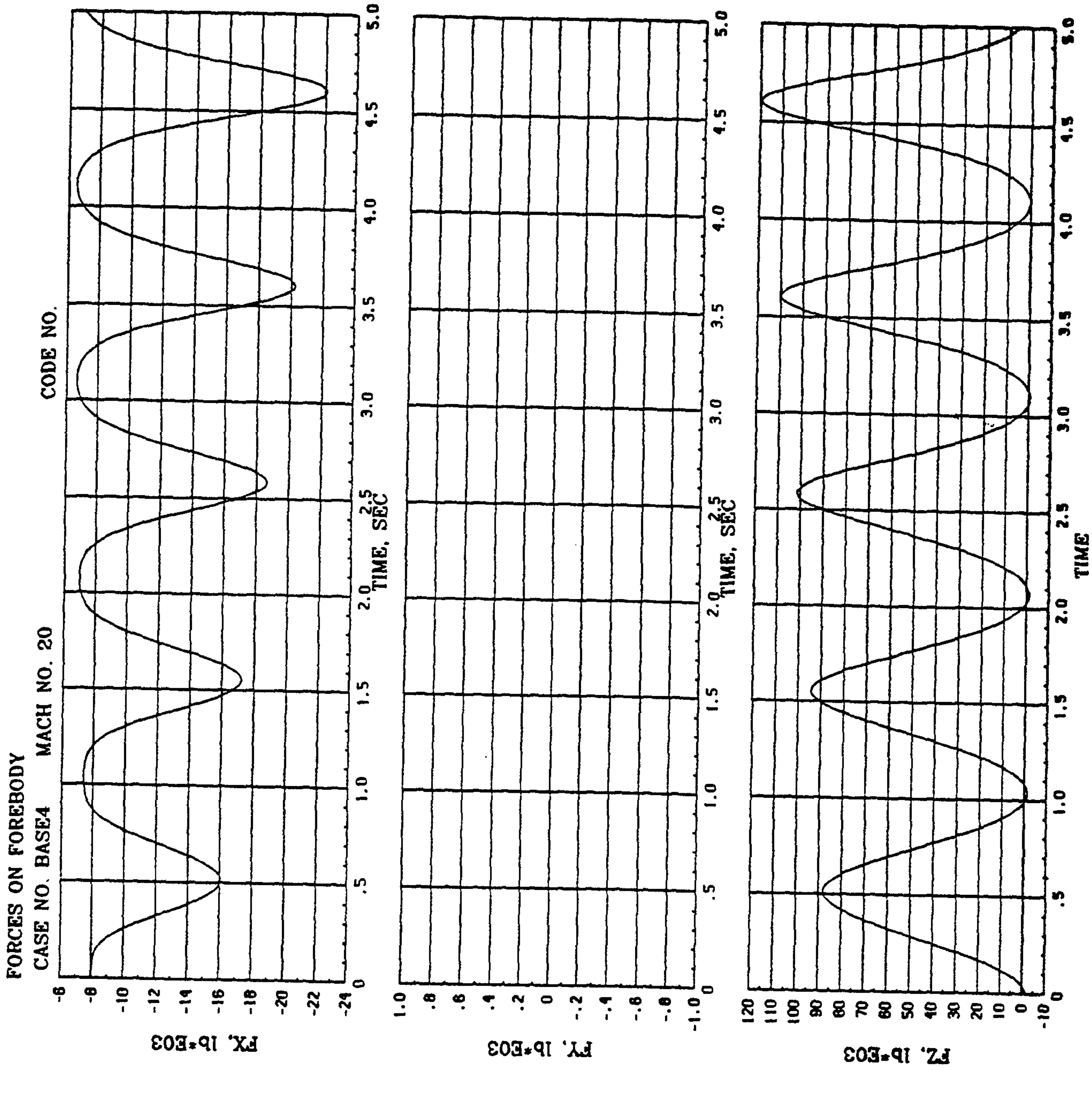
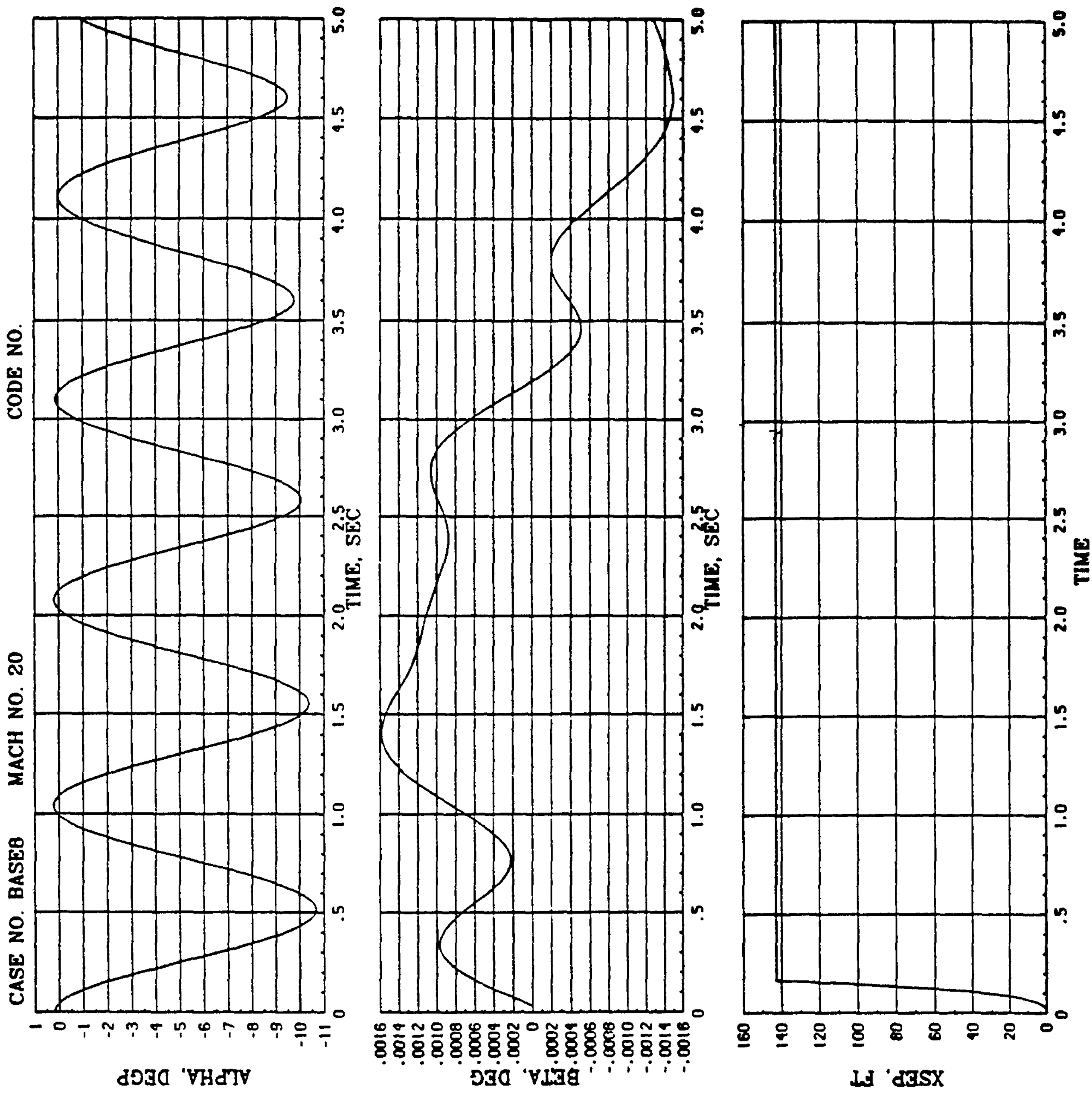
-.20
-.22

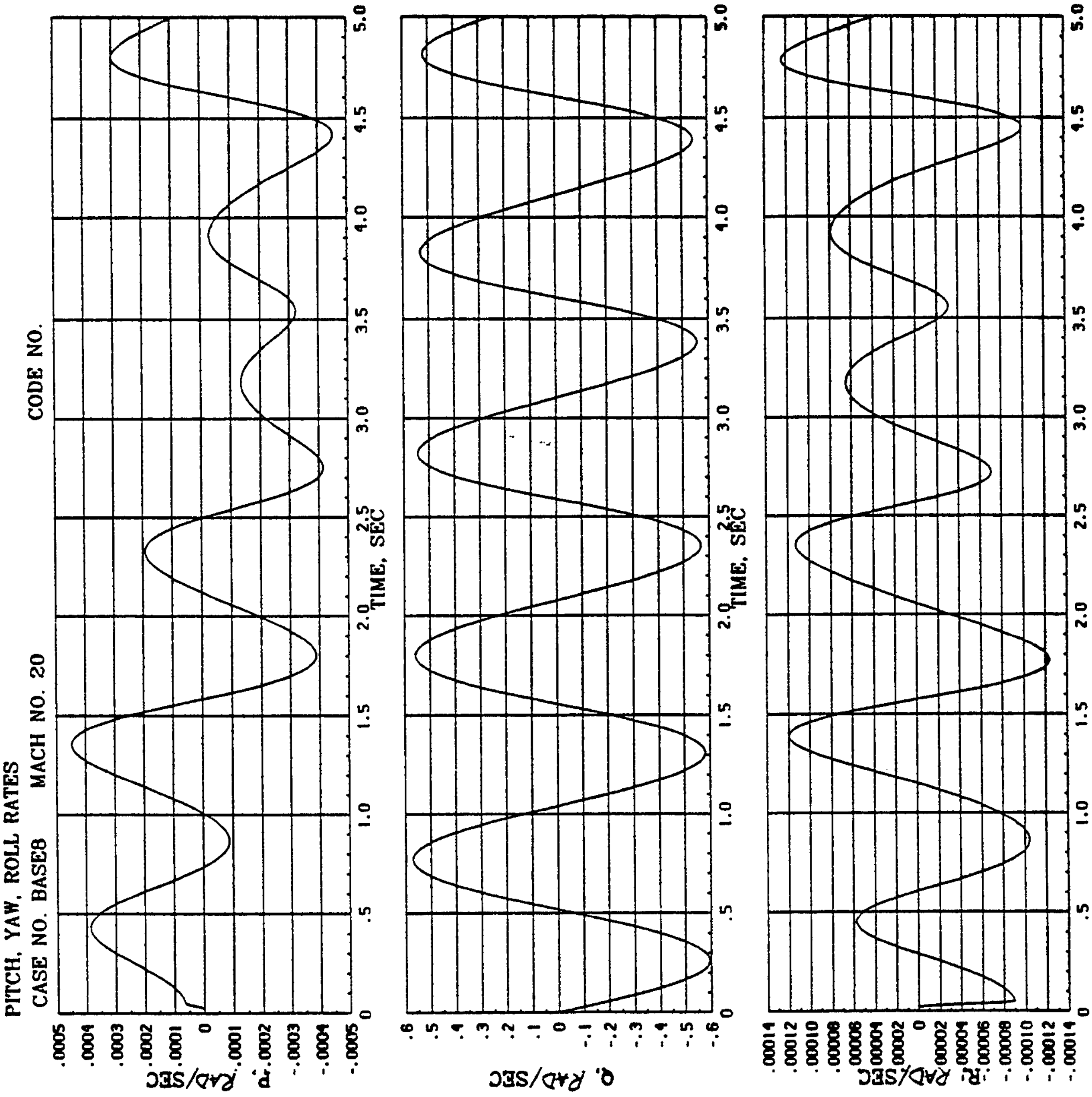


FORCES ON FOREBODY
CASE NO. BASE4
MACH NO. 20
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

Case 14

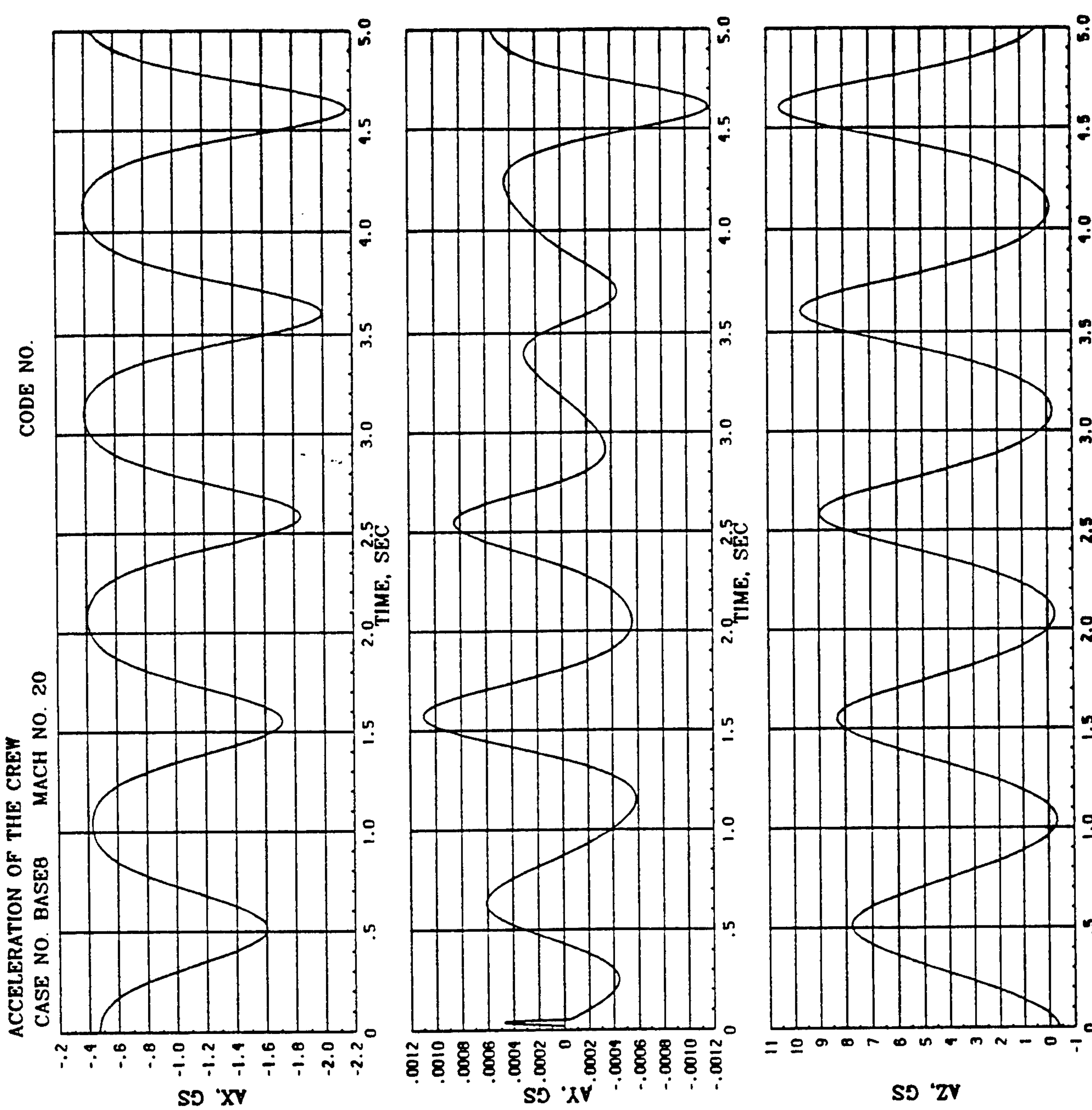

CASE NO. BASE8
MACH NO. 20
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

Case 14



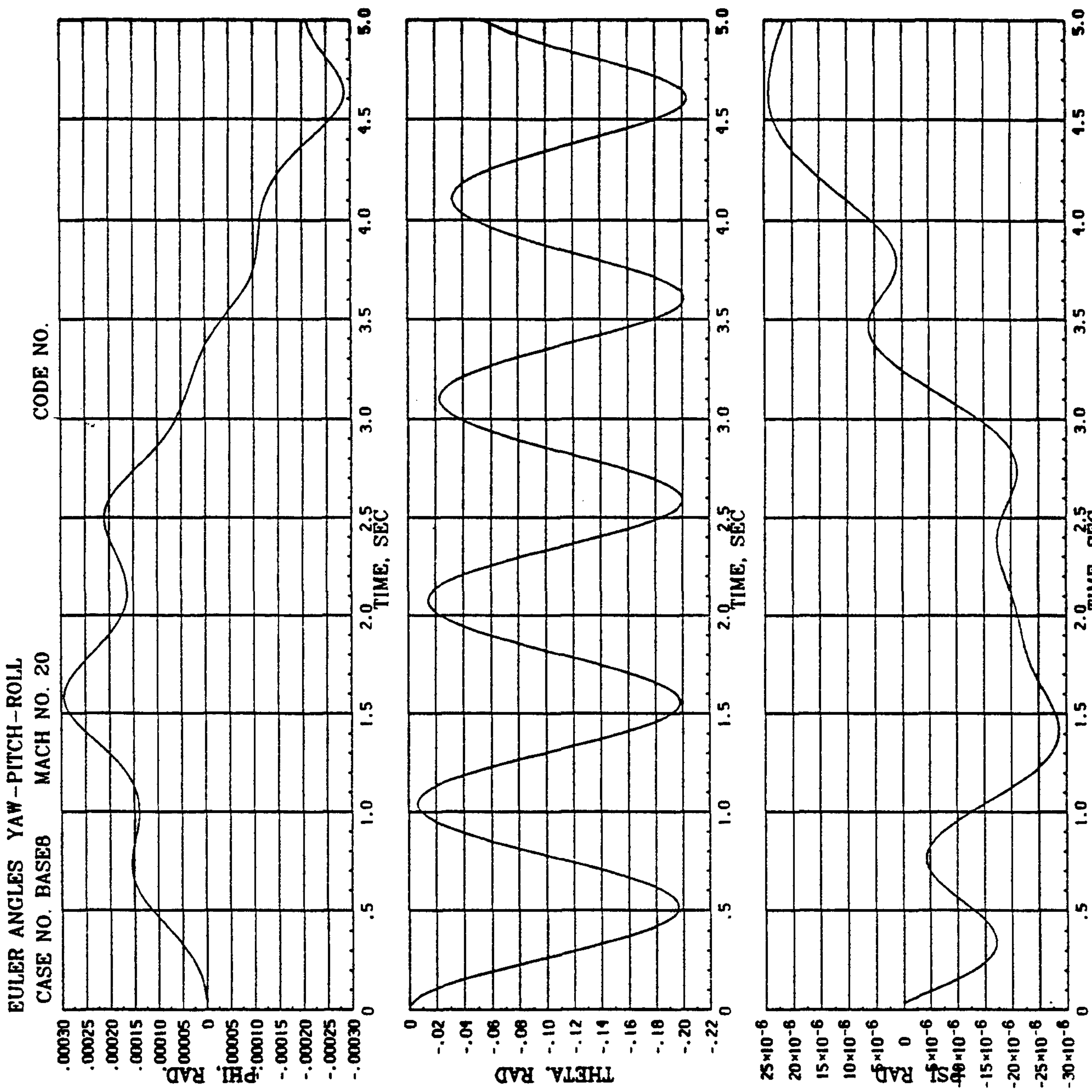
PITCH, YAW, ROLL RATES
CASE NO. BASE8
MACH NO. 20
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC

Case 14

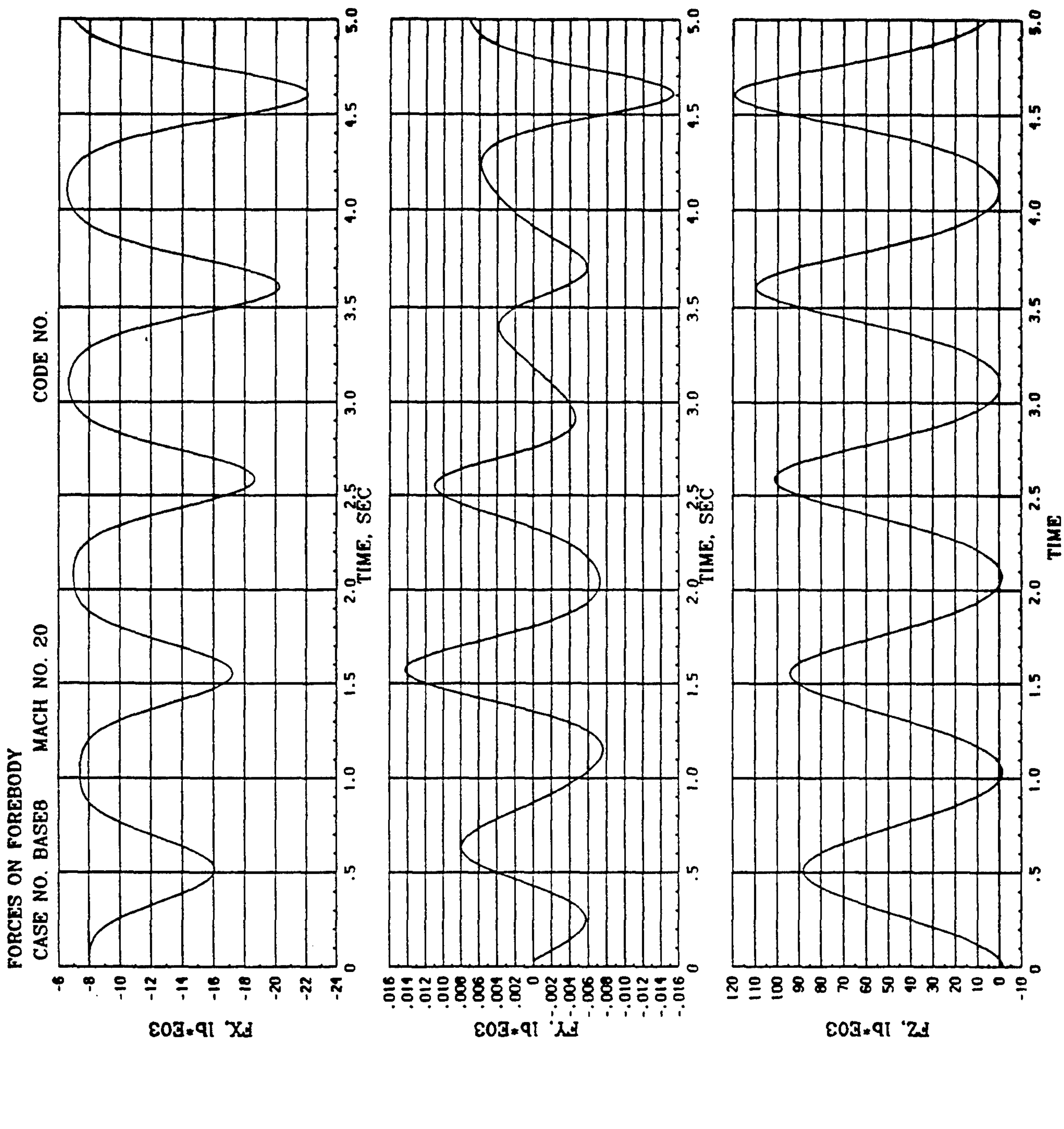


ACCELERATION OF THE CREW
CASE NO. BASES
MACH NO. 20
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

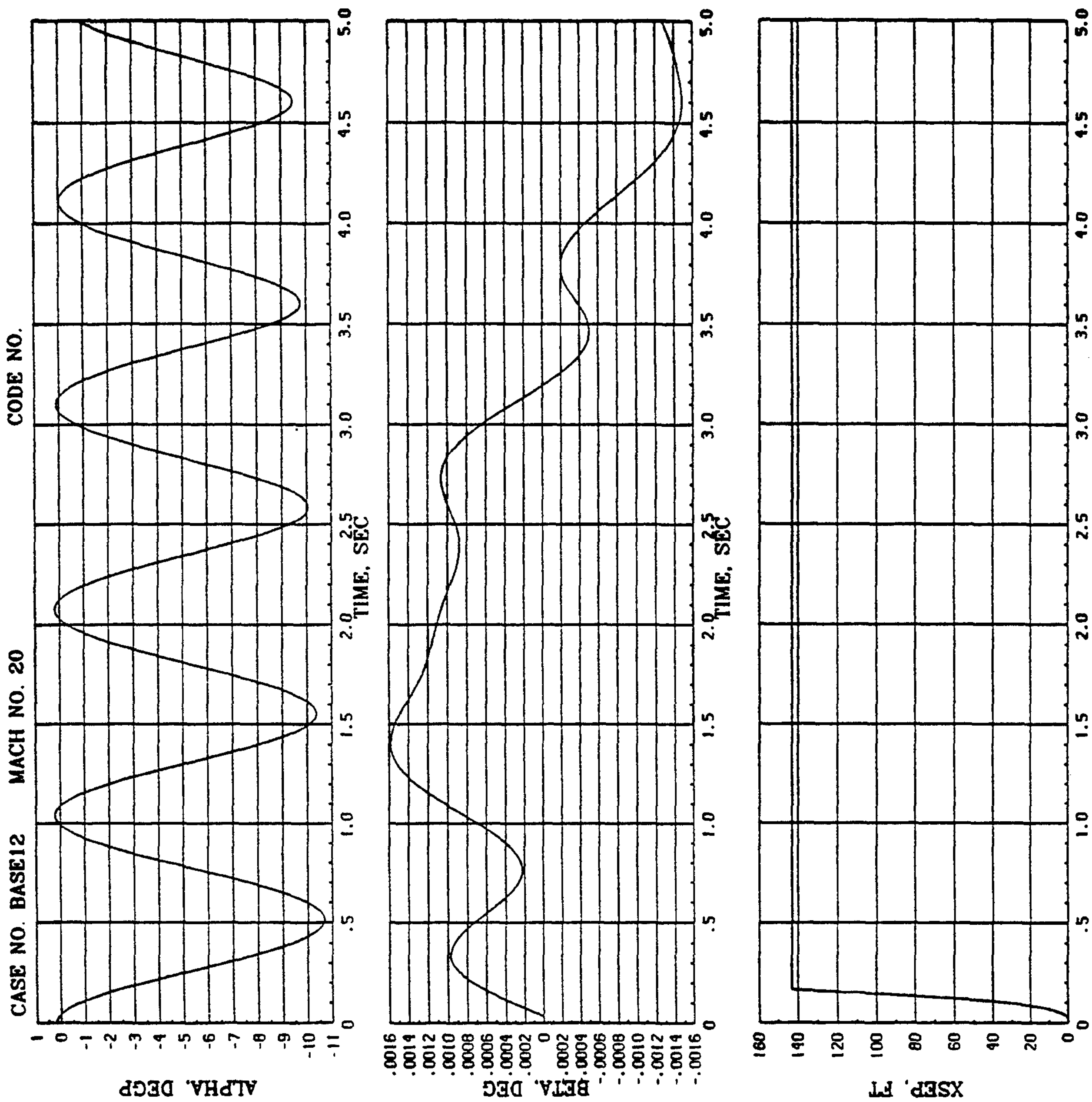
Case 14


EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE8 MACH NO. 20
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
TIME, SEC
TIME, SEC

Case 14

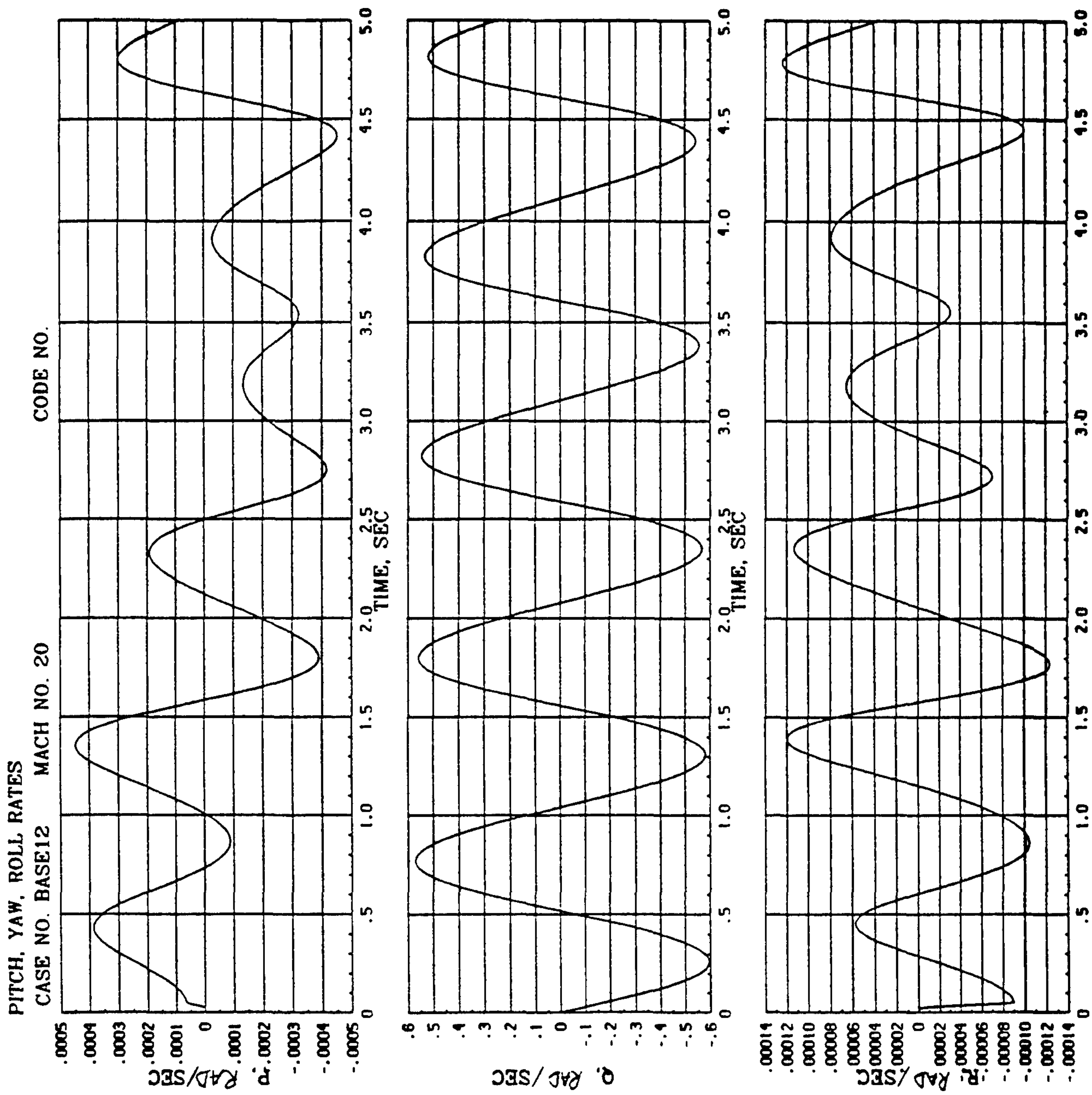

FORCES ON FOREBODY
CASE NO. BASE8
MACH NO. 20
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

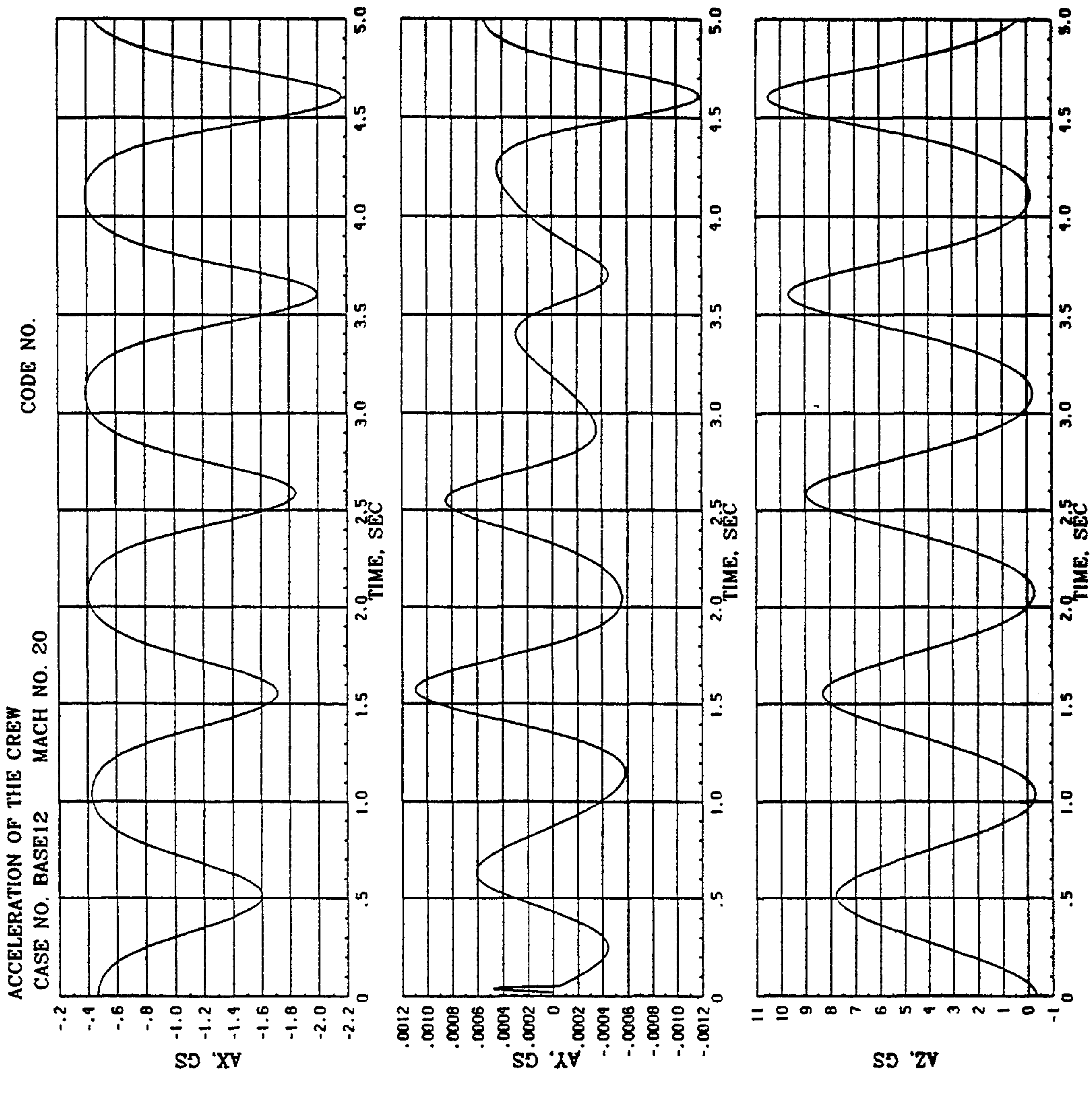
Case 15

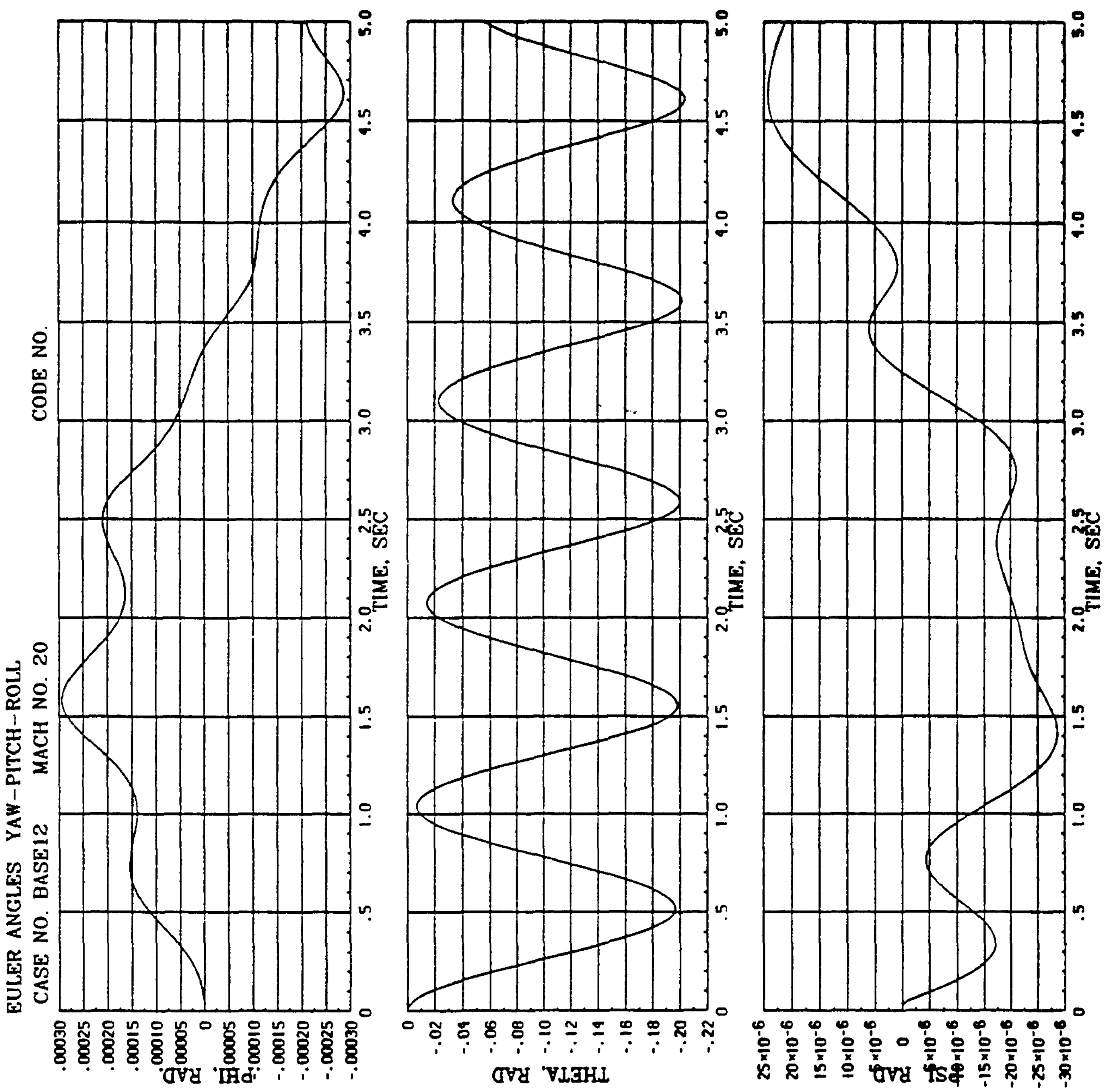


CASE NO. BASE12
MACH NO. 20
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

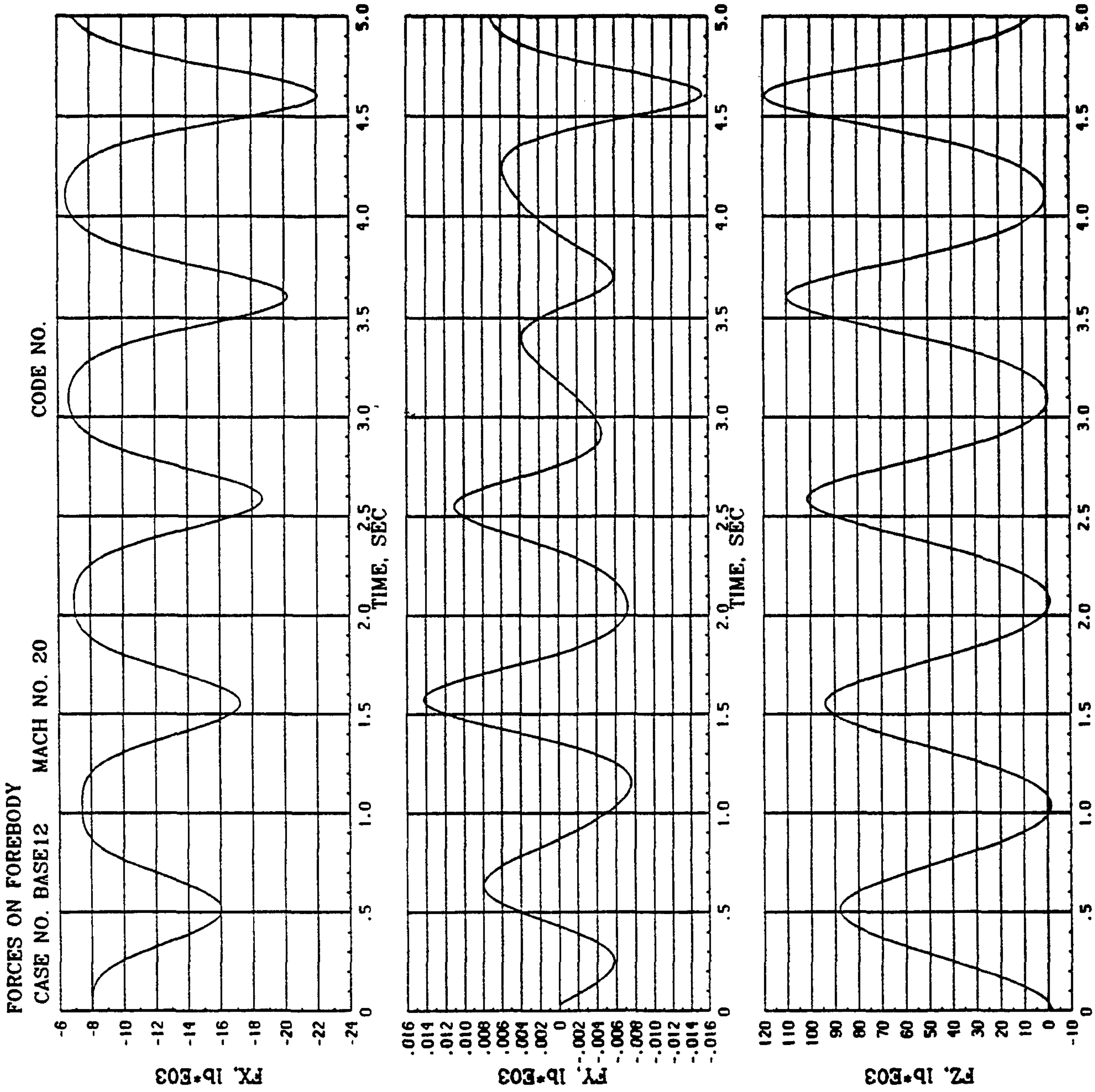
Case 15


PITCH, YAW, ROLL RATES
CASE NO. BASE12
MACH NO. 20
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC


ACCELERATION OF THE CREW
CASE NO. BASE12
MACH NO. 20
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
-.2
-.4
-.6
-.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
.0012
.0010
.0008
.0006
.0004
.0002
0
-.0002
-.0004
-.0006
-.0008
-.0010
-.0012
11
10
9
8
7
6
5
4
3
2
1
0
-1

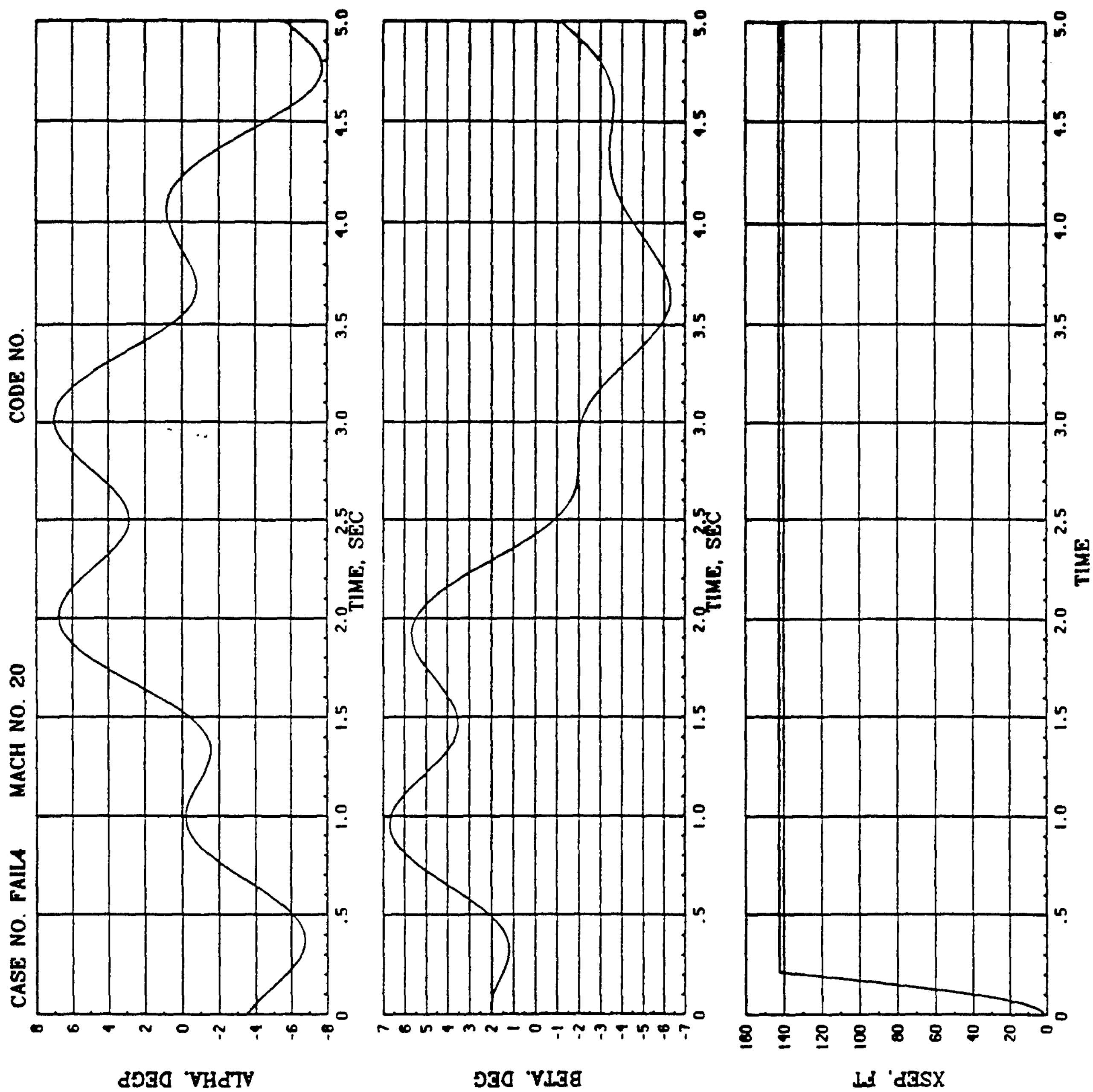

EULER ANGLES YAW-PITCH-ROLL
CASE NO. BASE12
MACH NO. 20
CODE NO.
PHI, RAD
.00030
.00025
.00020
.00015
.00010
.00005
0
-.00005
-.00010
-.00015
-.00020
-.00025
-.00030
THETA, RAD
0
-.02
-.04
-.06
-.08
-.10
-.12
-.14
-.16
-.18
-.20
-.22
PSI, RAD
25×10⁻⁶
20×10⁻⁶
15×10⁻⁶
10×10⁻⁶
5×10⁻⁶
0
-5×10⁻⁶
-10×10⁻⁶
-15×10⁻⁶
-20×10⁻⁶
-25×10⁻⁶
-30×10⁻⁶
TIME, SEC
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

Case 15



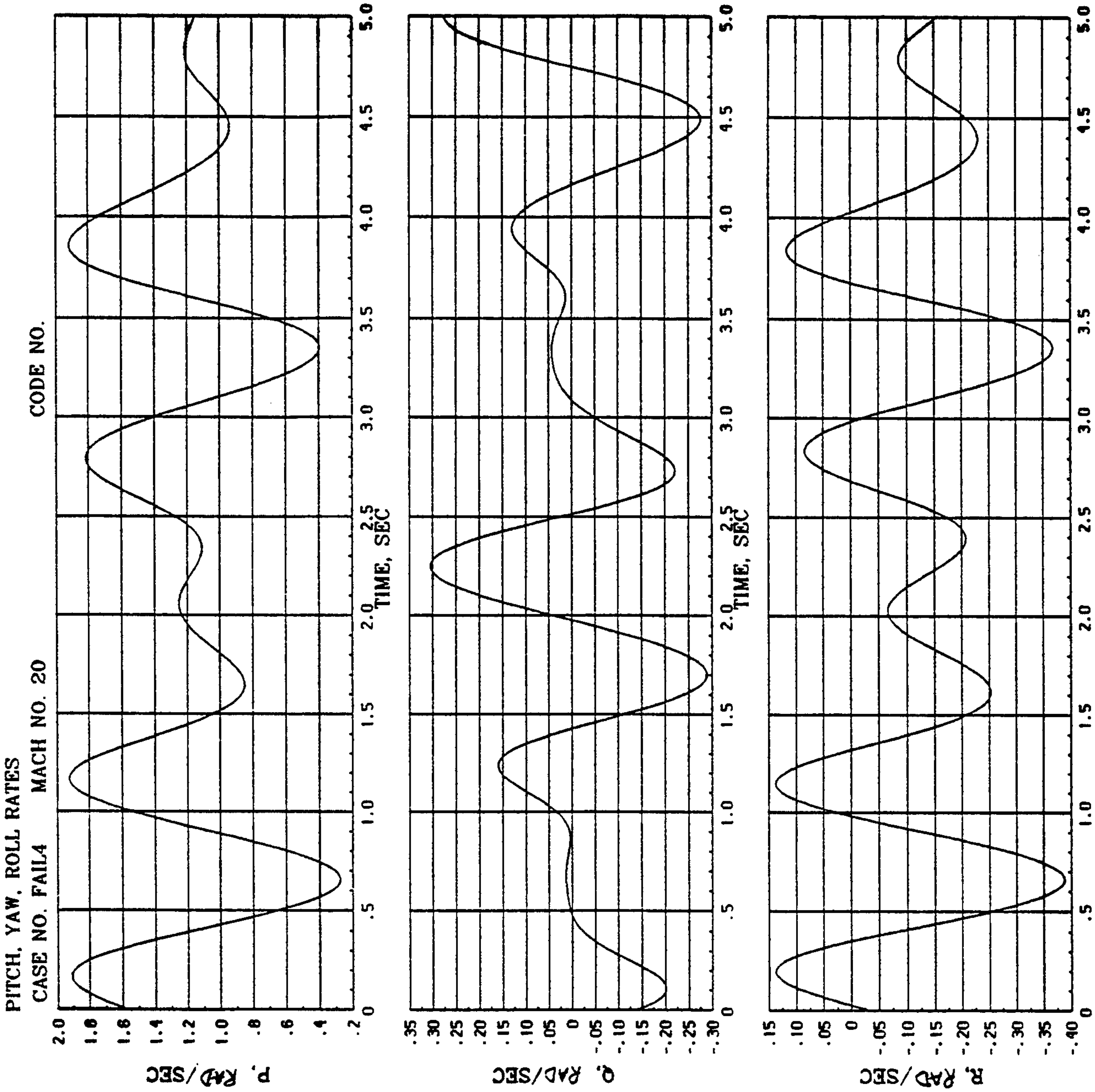
FORCES ON FOREBODY
CASE NO. BASE12
MACH NO. 20
CODE NO.
FX, lb*E03
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
TIME, SEC
FY, lb*E03
.016
.014
.012
.010
.008
.006
.004
.002
0
-.002
-.004
-.006
-.008
-.010
-.012
-.014
-.016
TIME, SEC
FZ, lb*E03
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
TIME

Case 16

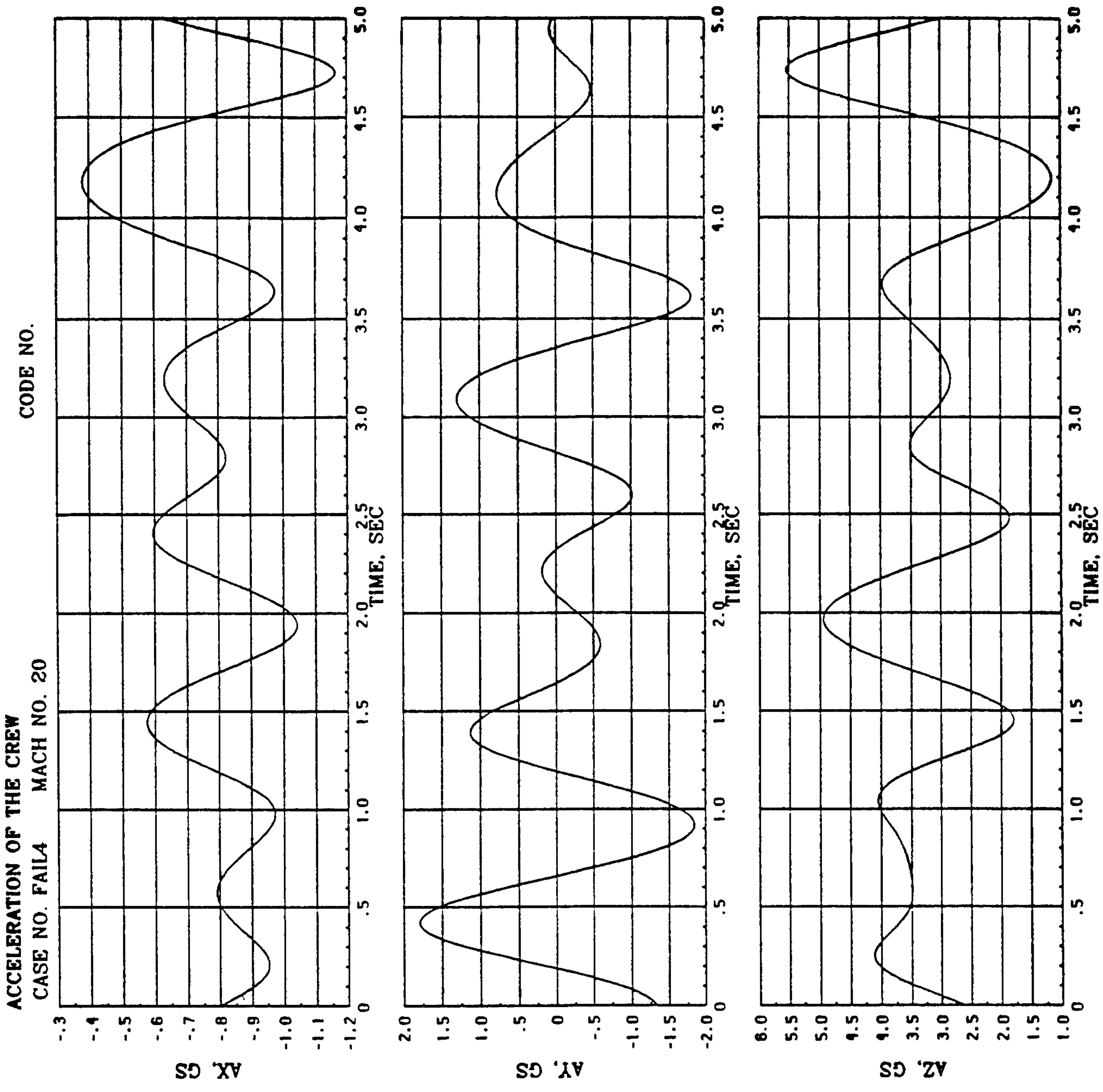


CASE NO. FAIL4
MACH NO. 20
CODE NO.
ALPHA, DEGP
BETA, DEG
XSEP, FT
TIME, SEC
TIME, SEC
TIME

Case 16

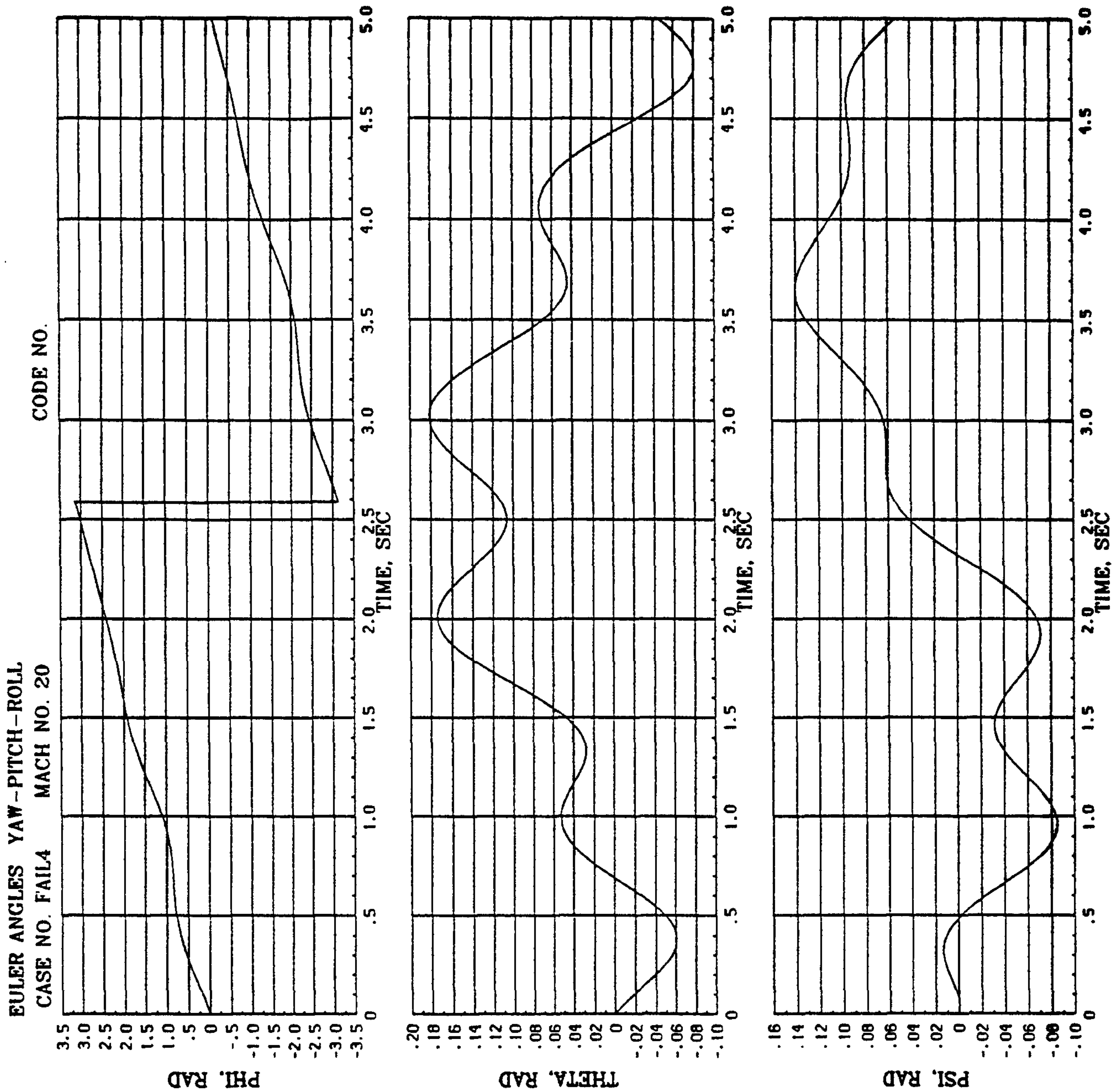


PITCH, YAW, ROLL RATES
CASE NO. FAIL4
MACH NO. 20
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC



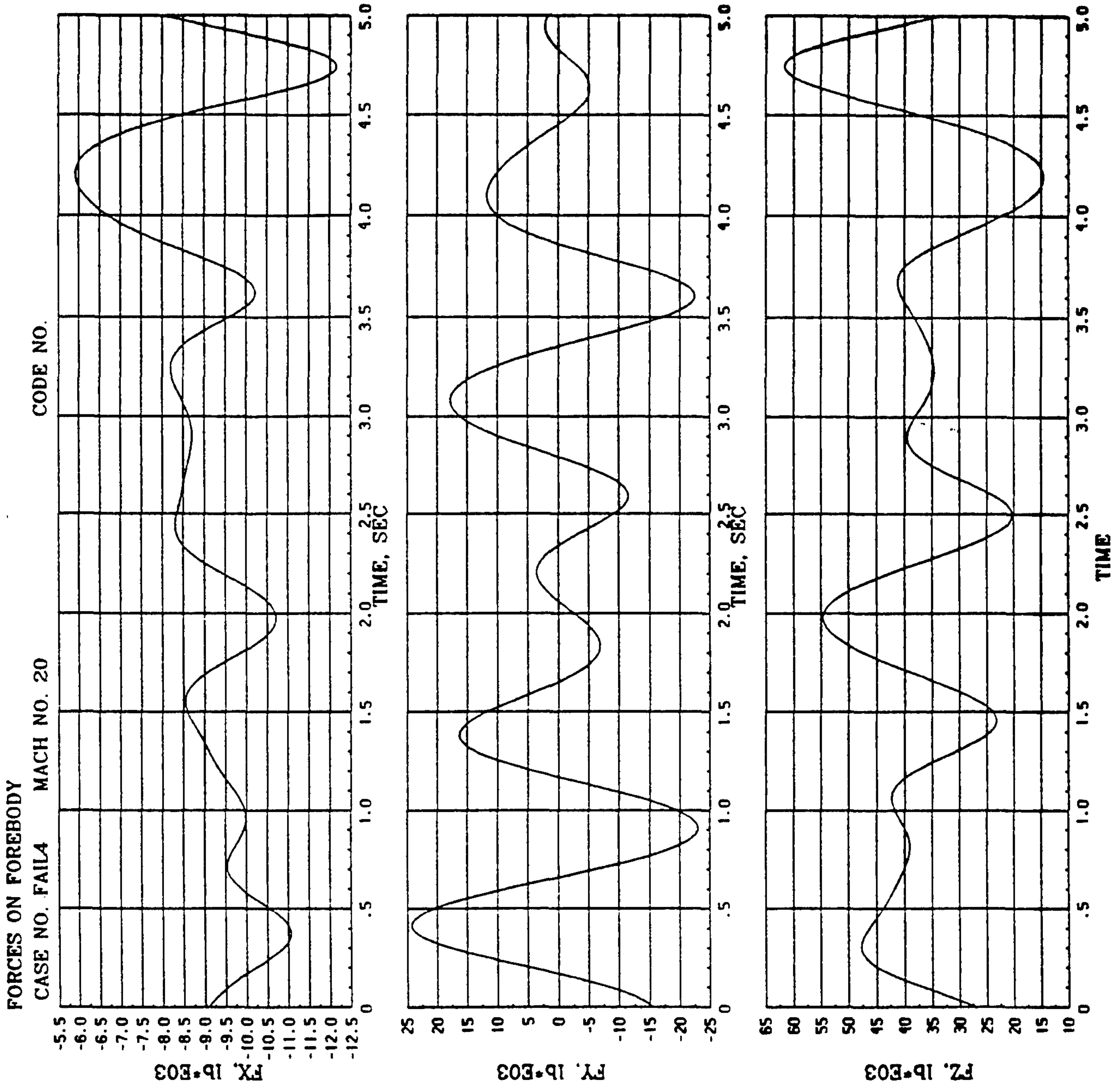
ACCELERATION OF THE CREW
CASE NO. FAIL4 MACH NO. 20
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 16



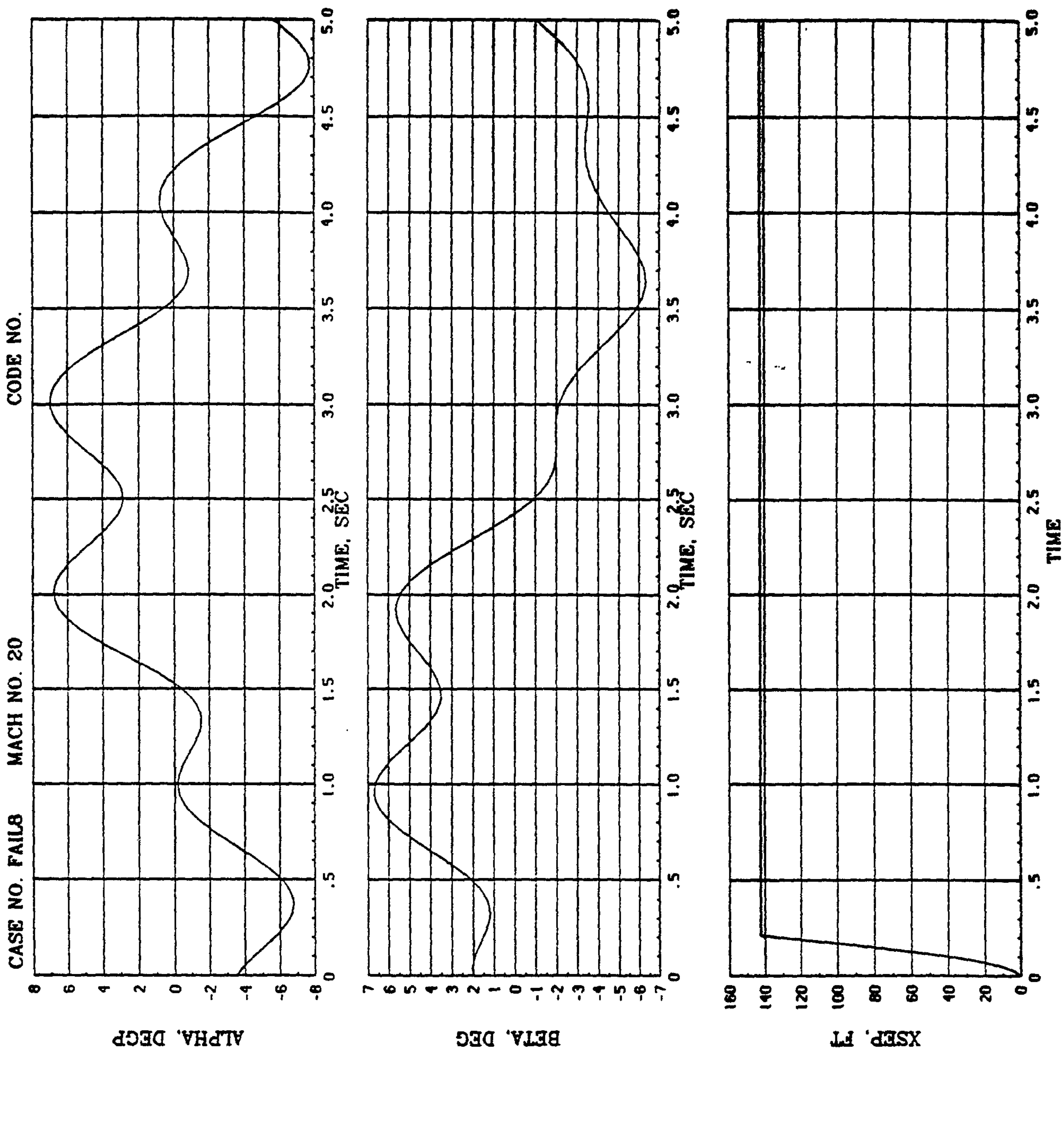
EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL4
MACH NO. 20
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC

Case 16

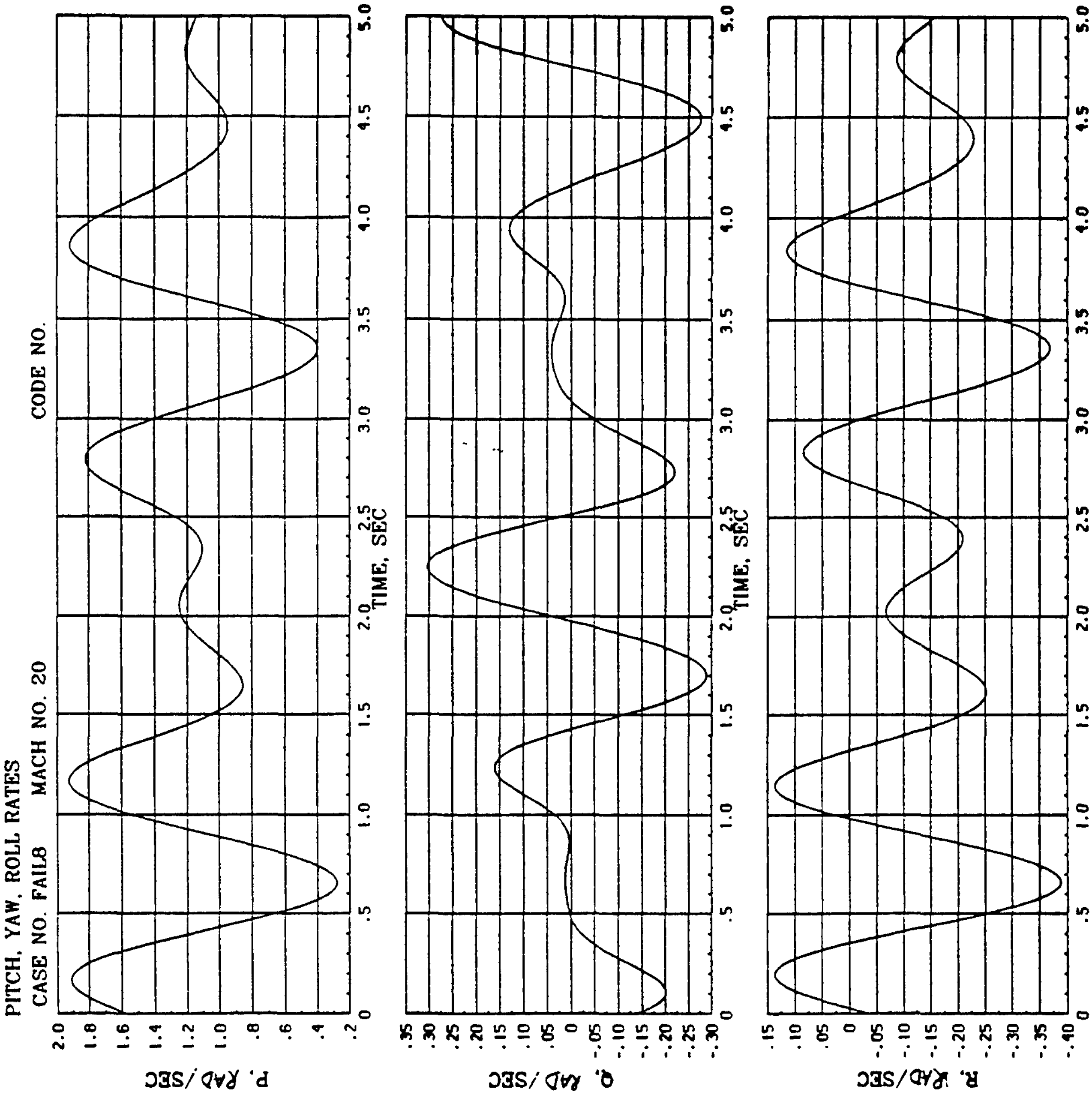


FORCES ON FOREBODY
CASE NO. FAIL4
MACH NO. 20
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

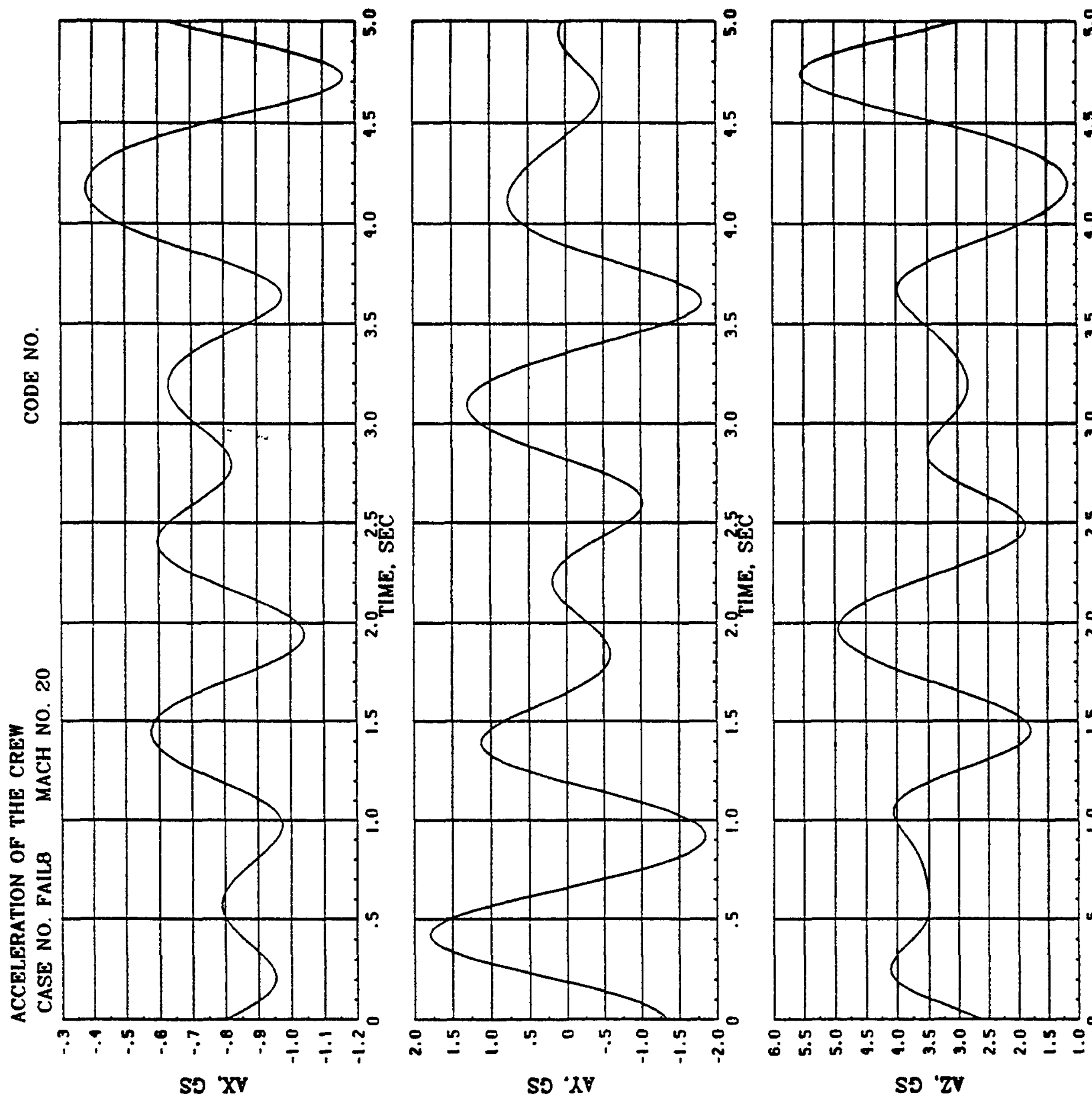
Case 17



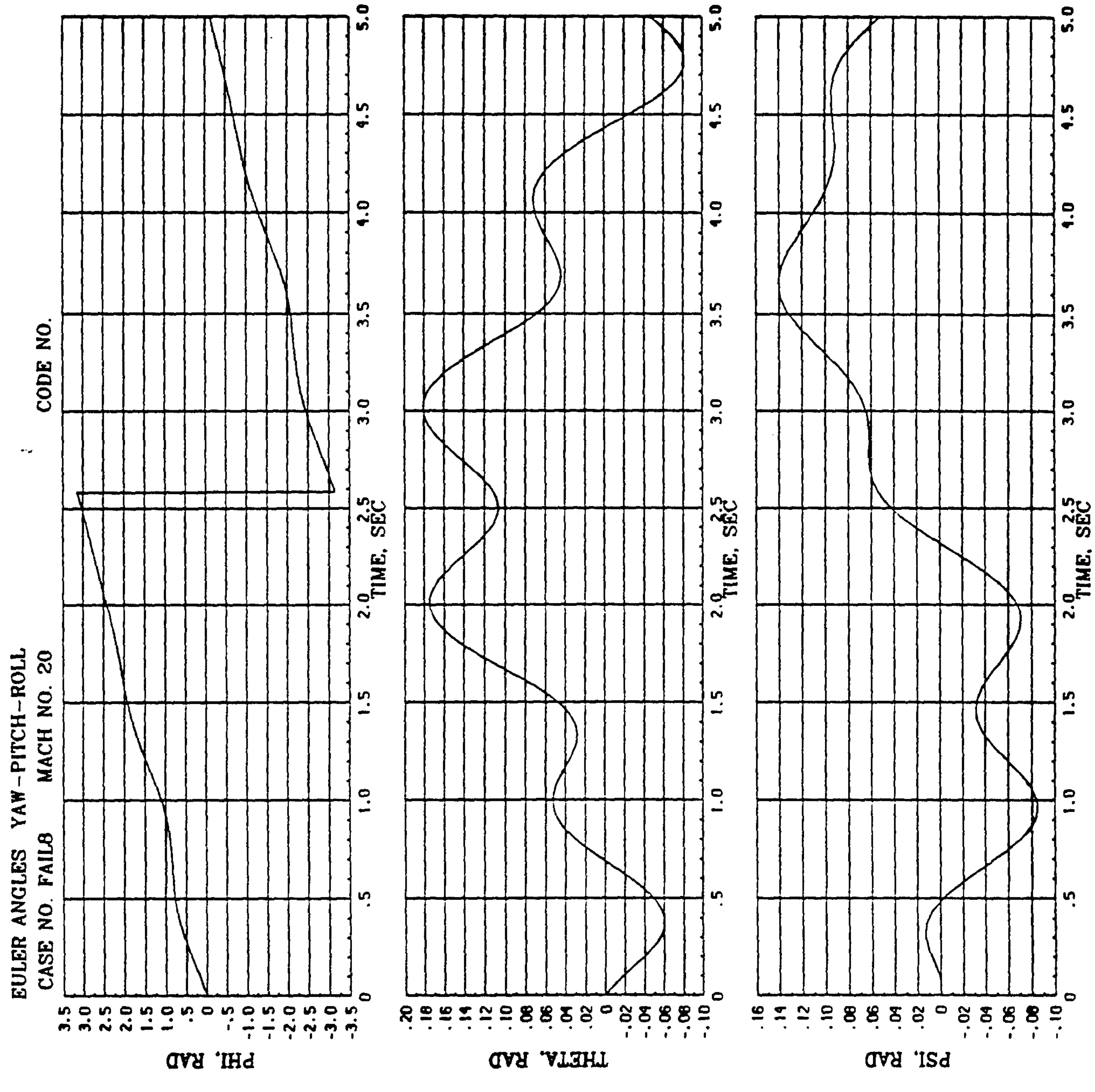
CASE NO. FAIL8
MACH NO. 20
CODE NO.
ALPHA, DEGP
BETA, DEG
XSEP, FT
TIME, SEC
TIME, SEC
TIME


PITCH, YAW, ROLL RATES
CASE NO. FAIL8
MACH NO. 20
CODE NO.
P, RAD/SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC
TIME, SEC
TIME, SEC

Case 17

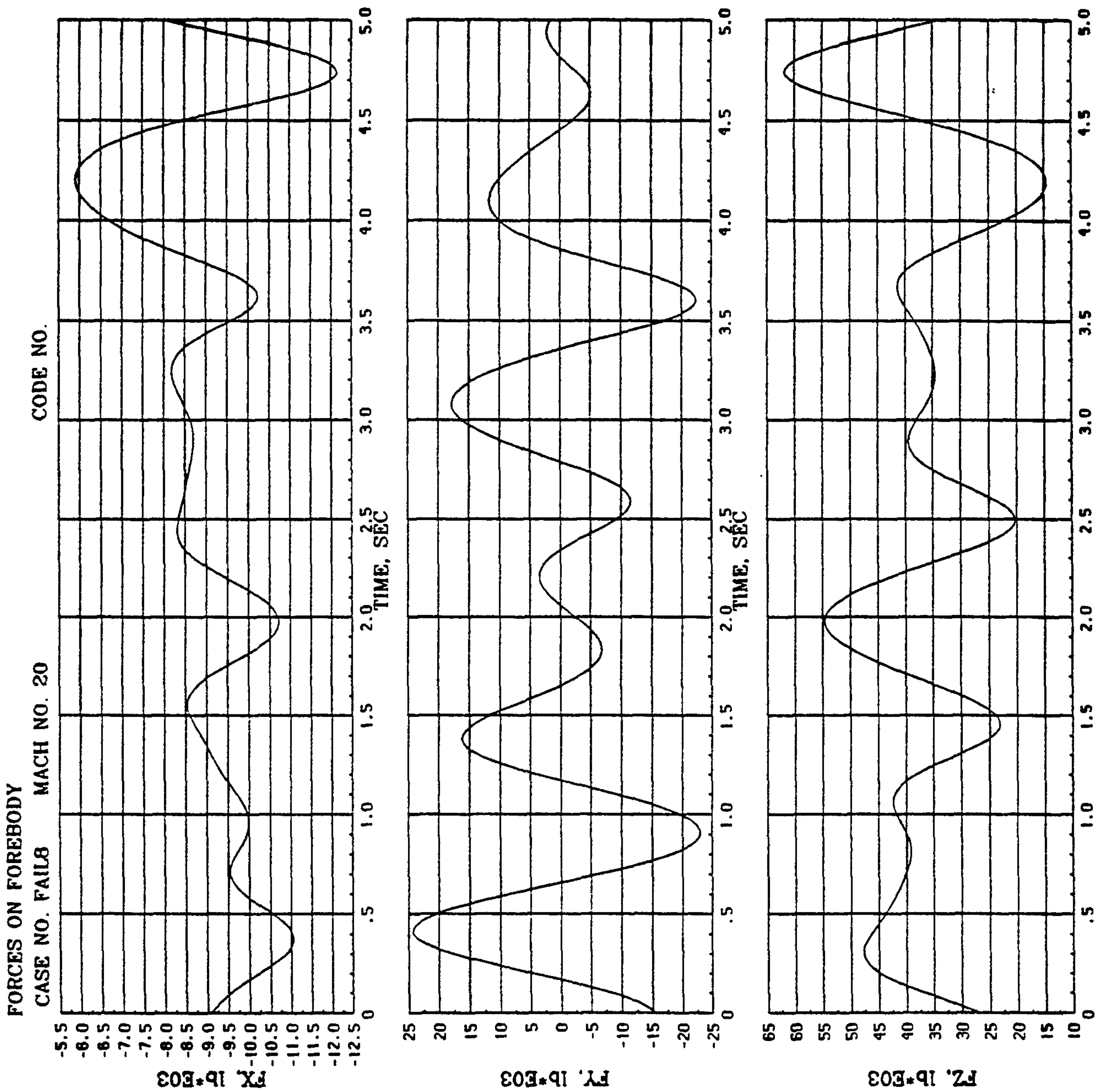

ACCELERATION OF THE CREW
CASE NO. FAIL8
MACH NO. 20
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC
TIME, SEC
TIME, SEC

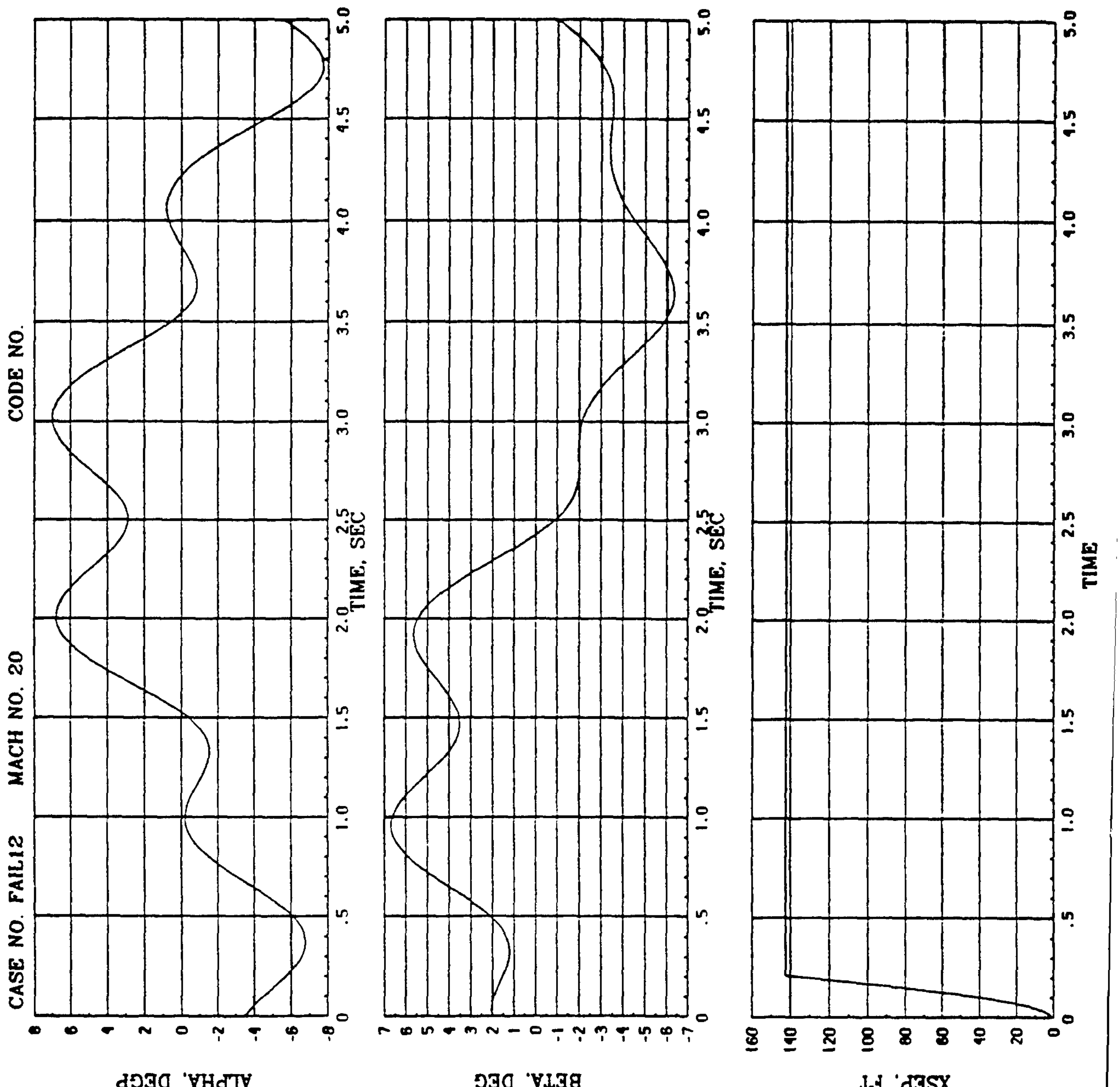
Case 17



EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL8 MACH NO. 20
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC

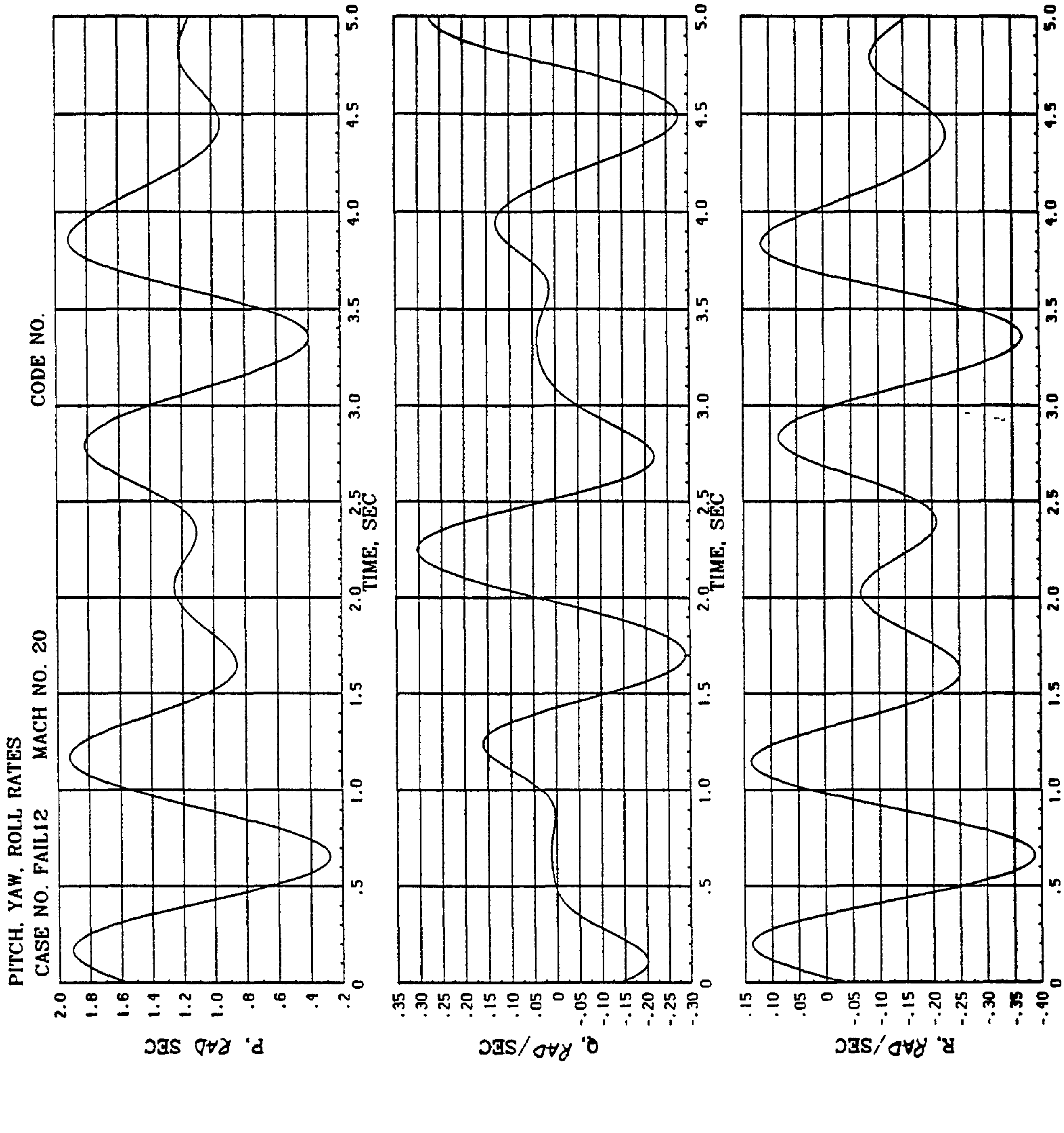
Case 17


FORCES ON FOREBODY
CASE NO. FAIL8
MACH NO. 20
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

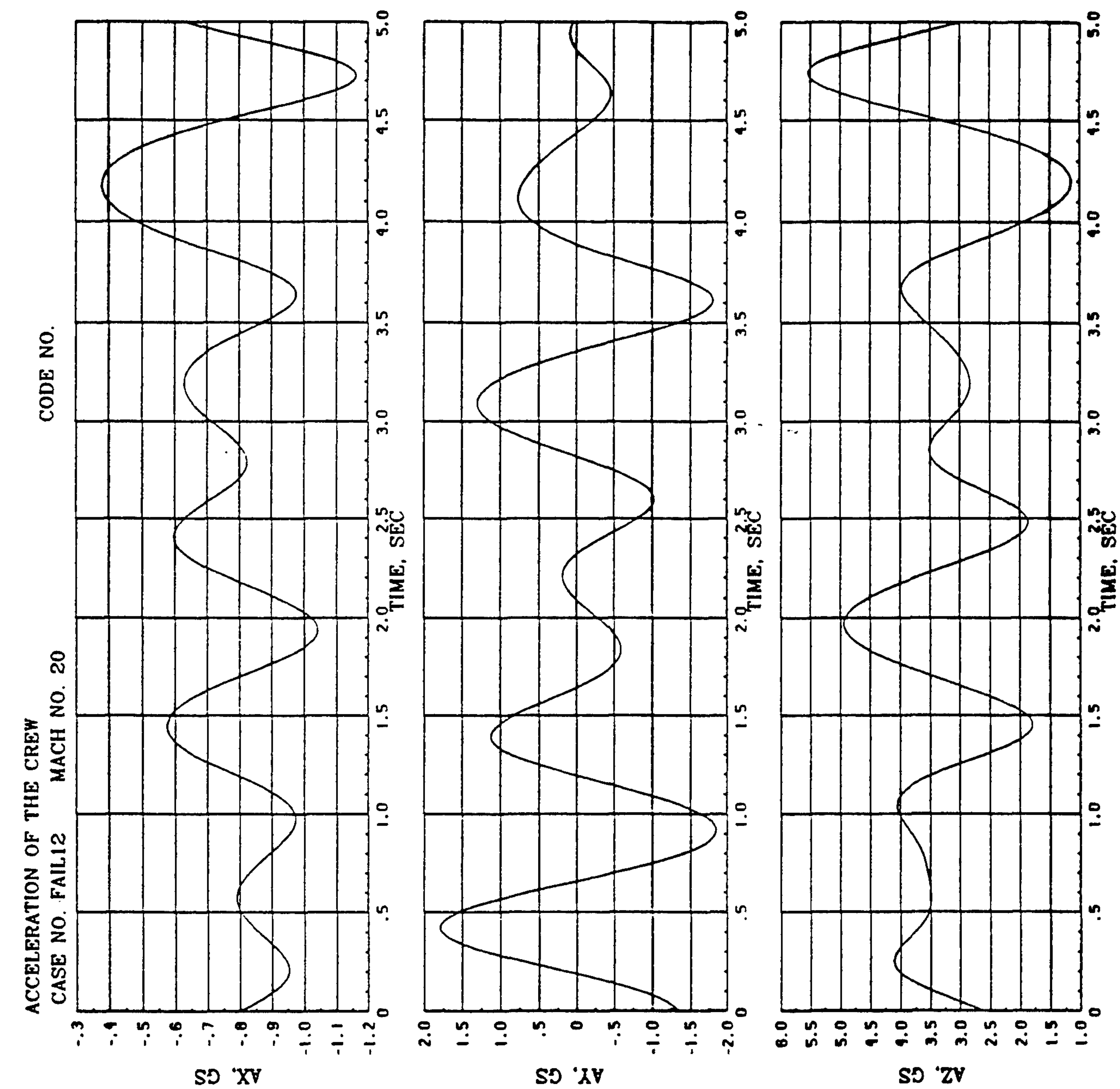


CASE NO. FAIL12
MACH NO. 20
CODE NO.
ALPHA, DEGP
TIME, SEC
BETA, DEG
TIME, SEC
XSEP, FT
TIME

Case 18

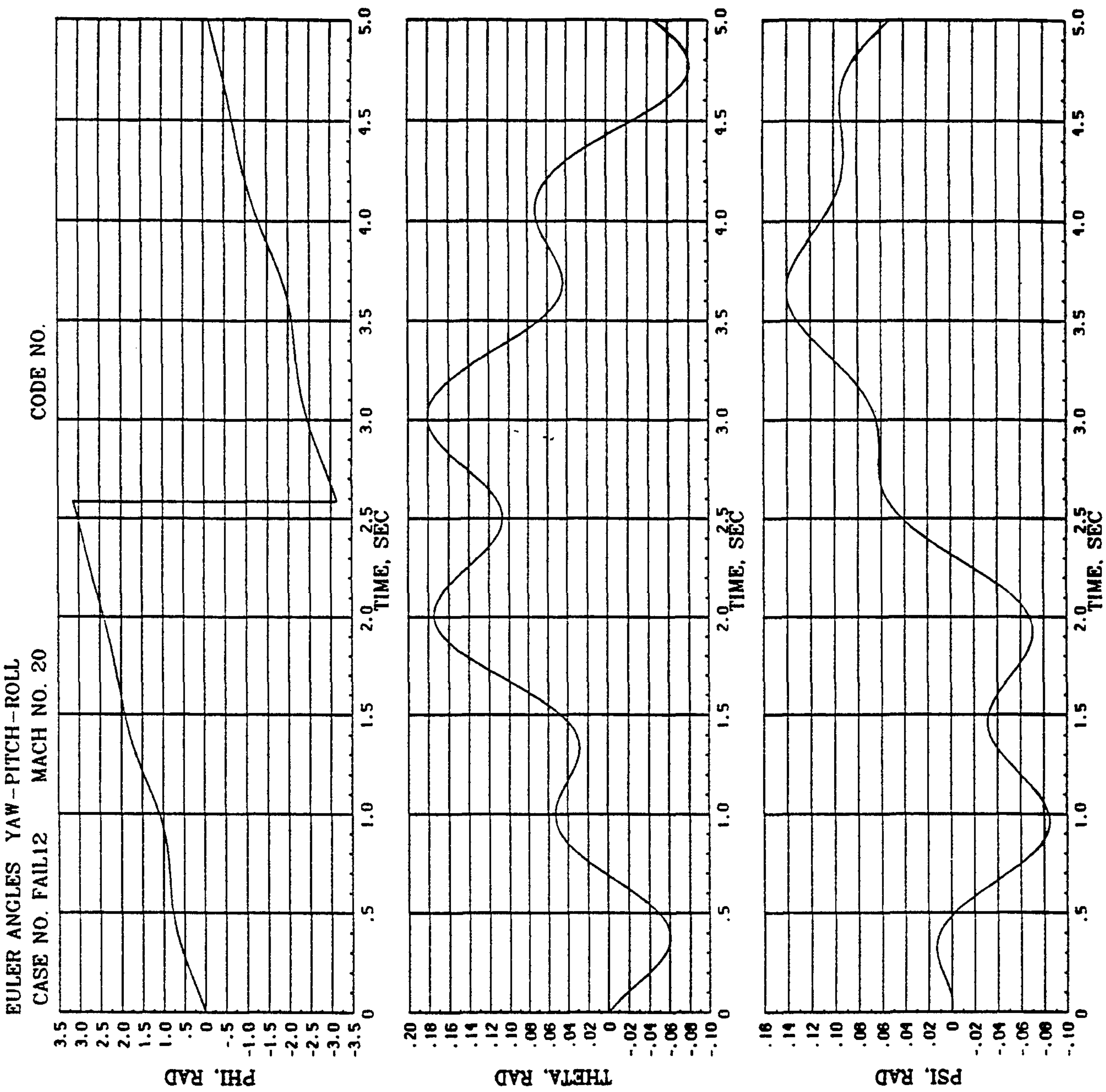

PITCH, YAW, ROLL RATES
CASE NO. FAIL12
MACH NO. 20
CODE NO.
P, RAD SEC
Q, RAD/SEC
R, RAD/SEC
TIME, SEC

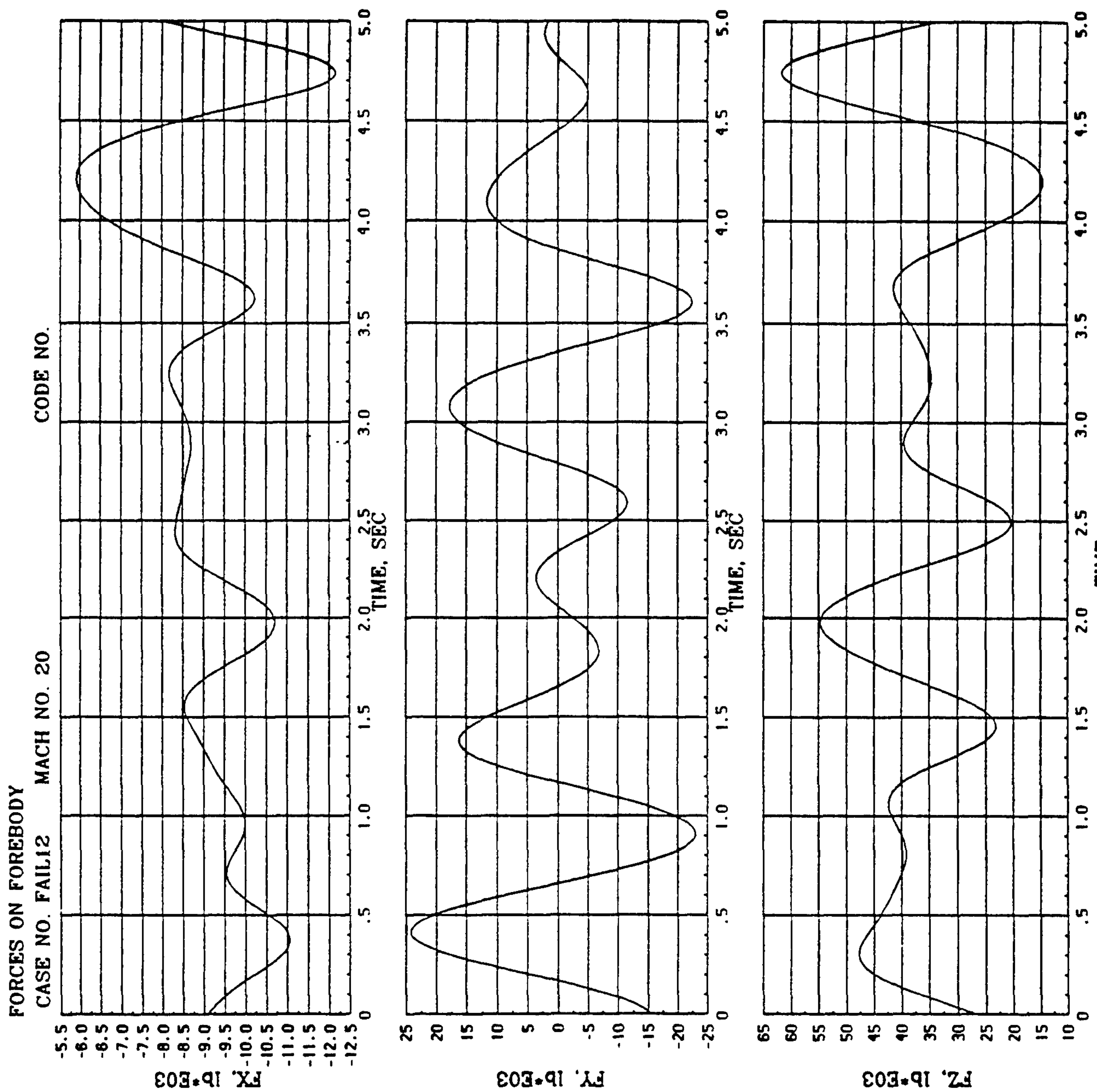
Case 18



ACCELERATION OF THE CREW
CASE NO. FAIL12
MACH NO. 20
CODE NO.
AX, GS
AY, GS
AZ, GS
TIME, SEC

Case 18


EULER ANGLES YAW-PITCH-ROLL
CASE NO. FAIL12
MACH NO. 20
CODE NO.
PHI, RAD
THETA, RAD
PSI, RAD
TIME, SEC
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0


FORCES ON FOREBODY
CASE NO. FAIL12
MACH NO. 20
CODE NO.
FX, lb*E03
FY, lb*E03
FZ, lb*E03
TIME, SEC
TIME, SEC
TIME

APPENDIX E

Aerodynamics Analysis Results

This appendix contains the results of the aerodynamic analysis performed under Task IV. The results are presented for configuration refinements 1 and 2, and configuration refinement 2 adapted with the Inflatable Decelerator System. Refer to Tasks II and IV of this report for more information on each configuration and its associated aerodynamics.

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.60	32000.00	0.	2979.55	34.00	-0.97	0.00

ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02599	0.01792	0.00154	-1.45034	-0.05764	0.001492
-15.00	0.00	-0.01853	0.01386	0.00111	-1.33694	-0.05906	0.001490
-10.00	0.00	-0.01108	0.01125	0.00067	-0.98489	-0.06032	0.001492
-5.00	0.00	-0.00362	0.00985	0.00022	-0.36751	-0.05898	0.001492
0.00	0.00	0.00384	0.00944	-0.00022	0.40678	-0.05898	0.001492
5.00	0.00	0.01130	0.00985	-0.00066	1.14721	-0.06040	0.001490
10.00	0.00	0.01875	0.01125	-0.00111	1.66667	-0.05898	0.001492
15.00	0.00	0.02621	0.01386	-0.00155	1.89105	-0.05764	0.001492
20.00	0.00	0.03367	0.01792	-0.00198	1.87891	-0.05764	0.001492

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.90	37000.00	0.	2979.55	34.00	-0.97	0.00

ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02599	0.02351	0.00206	-1.10549	-0.07507	0.001492
-15.00	0.00	-0.01853	0.01945	0.00150	-0.95270	-0.07651	0.001490
-10.00	0.00	-0.01108	0.01684	0.00093	-0.65796	-0.07641	0.001492
-5.00	0.00	-0.00362	0.01544	0.00036	-0.23446	-0.07775	0.001492
0.00	0.00	0.00384	0.01503	-0.00022	0.25549	-0.07775	0.001492
5.00	0.00	0.01130	0.01544	-0.00080	0.73187	-0.07651	0.001490
10.00	0.00	0.01875	0.01684	-0.00137	1.11342	-0.07641	0.001492
15.00	0.00	0.02621	0.01945	-0.00194	1.34756	-0.07507	0.001492
20.00	0.00	0.03367	0.02351	-0.00250	1.43216	-0.07507	0.001492

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.10	39000.00	0.	2979.55	34.00	-0.97	0.00

ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02599	0.02865	0.00230	-0.90716	-0.08311	0.001492
-15.00	0.00	-0.01853	0.02450	0.00168	-0.75633	-0.08456	0.001490
-10.00	0.00	-0.01108	0.02186	0.00105	-0.50686	-0.08445	0.001492
-5.00	0.00	-0.00362	0.02044	0.00042	-0.17710	-0.08579	0.001492
0.00	0.00	0.00384	0.02003	-0.00022	0.19171	-0.08579	0.001492
5.00	0.00	0.01130	0.02044	-0.00086	0.55284	-0.08456	0.001490
10.00	0.00	0.01875	0.02186	-0.00149	0.85773	-0.08445	0.001492
15.00	0.00	0.02621	0.02450	-0.00212	1.06980	-0.08311	0.001492
20.00	0.00	0.03367	0.02865	-0.00274	1.17522	-0.08311	0.001492

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.20	41500.00	0.	2979.55	34.00	-0.97	0.00

ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02599	0.02772	0.00224	-0.93759	-0.08177	0.001492
-15.00	0.00	-0.01853	0.02357	0.00163	-0.78617	-0.08188	0.001490
-10.00	0.00	-0.01108	0.02093	0.00102	-0.52938	-0.08311	0.001492
-5.00	0.00	-0.00362	0.01951	0.00040	-0.18555	-0.08311	0.001492
0.00	0.00	0.00384	0.01910	-0.00022	0.20105	-0.08311	0.001492
5.00	0.00	0.01130	0.01951	-0.00084	0.57919	-0.08322	0.001490
10.00	0.00	0.01875	0.02093	-0.00146	0.89584	-0.08177	0.001492
15.00	0.00	0.02621	0.02357	-0.00207	1.11201	-0.08177	0.001492
20.00	0.00	0.03367	0.02772	-0.00268	1.21465	-0.08177	0.001492

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.50	45500.00	0.	2979.55	34.00	-0.97	0.00

ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02599	0.02417	0.00194	-1.07530	-0.07229	0.001492

-10.00	0.00	-0.01108	0.01719	0.00087	-0.64456	-0.07373	0.001492
-5.00	0.00	-0.00362	0.01576	0.00032	-0.22970	-0.07239	0.001492
0.00	0.00	0.00384	0.01534	-0.00022	0.25033	-0.07239	0.001492
5.00	0.00	0.01130	0.01576	-0.00076	0.71700	-0.07383	0.001490
10.00	0.00	0.01875	0.01719	-0.00131	1.09075	-0.08445	0.001492
15.00	0.00	0.02621	0.01991	-0.00194	1.31642	-0.05898	0.001492
20.00	0.00	0.03367	0.02417	-0.00238	1.39305	-0.05898	0.001492

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	2.00	51000.00	0.	2979.55	34.00	-0.97	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02599	0.01995	0.00153	-1.30276	-0.05898	0.001492
-15.00	0.00	-0.01853	0.01534	0.00109	-1.20795	-0.05772	0.001490
-10.00	0.00	-0.01108	0.01245	0.00066	-0.88996	-0.05898	0.001492
-5.00	0.00	-0.00362	0.01095	0.00022	-0.33059	-0.05898	0.001492
0.00	0.00	0.00384	0.01052	-0.00022	0.36502	-0.05898	0.001492
5.00	0.00	0.01130	0.01095	-0.00066	1.03196	-0.05906	0.001490
10.00	0.00	0.01875	0.01245	-0.00110	1.50602	-0.06702	0.001492
15.00	0.00	0.02621	0.01534	-0.00160	1.70860	-0.06702	0.001492
20.00	0.00	0.03367	0.02100	-0.00220	1.60333	-0.06702	0.001492

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	3.00	62000.00	0.	2979.55	34.00	-0.97	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02599	0.01656	0.00132	-1.56944	-0.06836	0.001492
-15.00	0.00	-0.01853	0.01125	0.00081	-1.64711	-0.04698	0.001490
-10.00	0.00	-0.01108	0.00818	0.00046	-1.35452	-0.04558	0.001492
-5.00	0.00	-0.00362	0.00638	0.00012	-0.56740	-0.04558	0.001492
0.00	0.00	0.00384	0.00593	-0.00022	0.64755	-0.04021	0.001492
5.00	0.00	0.01130	0.00638	-0.00052	1.77216	-0.05503	0.001490
10.00	0.00	0.01875	0.00818	-0.00093	2.29218	-0.06702	0.001492
15.00	0.00	0.02621	0.01380	-0.00143	1.89928	-0.06300	0.001492
20.00	0.00	0.03367	0.01950	-0.00190	1.72567	-0.06300	0.001492

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	5.00	76000.00	0.	2979.55	34.00	-0.97	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02750	0.01268	0.00109	-2.16877	-0.04824	0.001700
-15.00	0.00	-0.01900	0.00786	0.00068	-2.41730	-0.04750	0.001600
-10.00	0.00	-0.01100	0.00479	0.00030	-2.29645	-0.04143	0.001600
-5.00	0.00	-0.00400	0.00343	0.00001	-1.16618	-0.03426	0.001518
0.00	0.00	0.00359	0.00328	-0.00025	1.09451	-0.04336	0.001522
5.00	0.00	0.01120	0.00479	-0.00058	2.33820	-0.04819	0.001660
10.00	0.00	0.01950	0.00786	-0.00098	2.48092	-0.05474	0.001900
15.00	0.00	0.02900	0.01210	-0.00150	2.39669	-0.05789	0.001900
20.00	0.00	0.03850	0.01850	-0.00205	2.08108	-0.05789	0.001900

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	10.00	106000.00	0.	2979.55	34.00	-0.97	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02787	0.01099	0.00089	-2.53594	-0.04028	0.001738
-15.00	0.00	-0.01918	0.00649	0.00054	-2.95532	-0.03585	0.001618
-10.00	0.00	-0.01109	0.00355	0.00025	-3.12394	-0.03385	0.001418
5.00	0.00	-0.00400	0.00209	0.00001	-1.91388	-0.03631	0.001432
0.00	0.00	0.00316	0.00196	-0.00025	1.61224	-0.04253	0.001532
5.00	0.00	0.01092	0.00349	-0.00058	3.12594	-0.05098	0.001844
10.00	0.00	0.02014	0.00652	[illegible]	[illegible]	[illegible]	[illegible]

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	16.00	140000.00	0.	2979.55	34.00	-0.97	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02684	0.01023	0.00081	-2.62366	-0.03878	0.001702
-15.00	0.00	-0.01833	0.00590	0.00048	-3.10678	-0.03403	0.001528
-10.00	0.00	-0.01069	0.00308	0.00022	-3.47078	-0.03250	0.001354
-5.00	0.00	-0.00392	0.00164	0.00000	-2.39024	-0.03429	0.001400
0.00	0.00	0.00308	0.00151	-0.00024	2.03973	-0.04111	0.001508
5.00	0.00	0.01062	0.00302	-0.00055	3.51656	-0.04983	0.001764
10.00	0.00	0.01945	0.00594	-0.00099	3.27441	-0.05677	0.002008
15.00	0.00	0.02949	0.01041	-0.00156	2.83285	-0.06157	0.002144
20.00	0.00	0.04021	0.01682	-0.00222	2.39061	-0.06157	0.002144

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	20.00	177000.00	0.	2979.55	34.00	-0.97	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02648	0.01041	0.00080	-2.54371	-0.03787	0.001690
-15.00	0.00	-0.01803	0.00610	0.00048	-2.95574	-0.03467	0.001500
-10.00	0.00	-0.01053	0.00331	0.00022	-3.18127	-0.03163	0.001328
-5.00	0.00	-0.00389	0.00189	0.00001	-2.05820	-0.03453	0.001390
0.00	0.00	0.00306	0.00176	-0.00023	1.73864	-0.04172	0.001486
5.00	0.00	0.01049	0.00325	-0.00054	3.22769	-0.05178	0.001738
10.00	0.00	0.01918	0.00615	-0.00099	3.11870	-0.05617	0.001994
15.00	0.00	0.02915	0.01059	-0.00155	2.75260	-0.06268	0.002138
20.00	0.00	0.03984	0.01698	-0.00222	2.34629	-0.06268	0.002138

LATERAL-DIRECTIONAL AERO

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.60	32000.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	**BETA**	**CL**	**CD**	**CM**	**C YAW**	**C ROLL**	**C SIDE**
-20.00	5.00	-0.00000	0.00000	0.00000	0.00092	0.00002	-0.00923
-15.00	5.00	-0.00000	0.00000	0.00000	0.00083	0.00001	-0.00837
-10.00	5.00	-0.00000	0.00000	0.00000	0.00074	0.00001	-0.00746
-5.00	5.00	-0.00000	0.00000	0.00000	0.00066	0.00000	-0.00665
0.00	5.00	0.00000	0.00000	-0.00000	0.00063	-0.00002	-0.00632
5.00	5.00	0.00000	0.00000	-0.00000	0.00065	-0.00004	-0.00657
10.00	5.00	0.00000	0.00000	-0.00000	0.00070	-0.00006	-0.00702
15.00	5.00	0.00000	0.00000	-0.00000	0.00074	-0.00009	-0.00746
20.00	5.00	0.00000	0.00000	-0.00000	0.00079	-0.00011	-0.00791

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.90	37000.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	**BETA**	**CL**	**CD**	**CM**	**C YAW**	**C ROLL**	**C SIDE**
-20.00	5.00	-0.00000	0.00000	0.00000	0.00130	0.00002	-0.01113
-15.00	5.00	-0.00000	0.00000	0.00000	0.00118	0.00001	-0.01010
-10.00	5.00	-0.00000	0.00000	0.00000	0.00105	0.00001	-0.00899
-5.00	5.00	-0.00000	0.00000	0.00000	0.00094	0.00000	-0.00802
0.00	5.00	0.00000	0.00000	-0.00000	0.00089	-0.00002	-0.00762
5.00	5.00	0.00000	0.00000	-0.00000	0.00093	-0.00004	-0.00792
10.00	5.00	0.00000	0.00000	-0.00000	0.00099	-0.00006	-0.00847
15.00	5.00	0.00000	0.00000	-0.00000	0.00104	-0.00009	-0.00890
20.00	5.00	0.00000	0.00000	-0.00000	0.00111	-0.00011	-0.00953

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.10	39000.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	**BETA**	**CL**	**CD**	**CM**	**C YAW**	**C ROLL**	**C SIDE**
-20.00	5.00	-0.00000	0.00000	0.00000	0.00147	0.00002	-0.01365
-15.00	5.00	-0.00000	0.00000	0.00000	0.00134	0.00001	-0.01239
-10.00	5.00	-0.00000	0.00000	0.00000	0.00119	0.00001	-0.01103
-5.00	5.00	-0.00000	0.00000	0.00000	0.00106	0.00000	-0.00984
0.00	5.00	0.00000	0.00000	-0.00000	0.00101	-0.00002	-0.00935
5.00	5.00	0.00000	0.00000	-0.00000	0.00105	-0.00004	-0.00971
10.00	5.00	0.00000	0.00000	-0.00000	0.00112	-0.00006	-0.01039
15.00	5.00	0.00000	0.00000	-0.00000	0.00119	-0.00009	-0.01104
20.00	5.00	0.00000	0.00000	-0.00000	0.00125	-0.00011	-0.01170

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.20	41500.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	**BETA**	**CL**	**CD**	**CM**	**C YAW**	**C ROLL**	**C SIDE**
-20.00	5.00	-0.00000	0.00000	0.00000	0.00143	0.00002	-0.01358
-15.00	5.00	-0.00000	0.00000	0.00000	0.00130	0.00001	-0.01232
-10.00	5.00	-0.00000	0.00000	0.00000	0.00116	0.00001	-0.01097
-5.00	5.00	-0.00000	0.00000	0.00000	0.00103	0.00000	-0.00978
0.00	5.00	0.00000	0.00000	-0.00000	0.00098	-0.00002	-0.00930
5.00	5.00	0.00000	0.00000	-0.00000	0.00102	-0.00004	-0.00964
10.00	5.00	0.00000	0.00000	-0.00000	0.00109	-0.00006	-0.01033
15.00	5.00	0.00000	0.00000	-0.00000	0.00116	-0.00009	-0.01098
20.00	5.00	0.00000	0.00000	-0.00000	0.00123	-0.00011	-0.01163

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.50	45500.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	**BETA**	**CL**	**CD**	**CM**	**C YAW**	**C ROLL**	**C SIDE**
-20.00	5.00	-0.00000	0.00000	0.00000	0.00122	0.00002	-0.01343
-15.00	5.00	-0.00000	0.00000	0.00000	0.00110	0.00001	-0.01219

-10.00	5.00	-0.00000	0.00000	0.00000	0.00098	0.00001	-0.01086
-5.00	5.00	-0.00000	0.00000	0.00000	0.00087	0.00000	-0.00968
0.00	5.00	0.00000	0.00000	-0.00000	0.00083	-0.00002	-0.00920
5.00	5.00	0.00000	0.00000	-0.00000	0.00086	-0.00004	-0.00956
10.00	5.00	0.00000	0.00000	-0.00000	0.00092	-0.00006	-0.01022
15.00	5.00	0.00000	0.00000	-0.00000	0.00098	-0.00009	-0.01087
20.00	5.00	0.00000	0.00000	-0.00000	0.00104	-0.00011	-0.01151

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	2.00	51000.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00092	0.00002	-0.01329
-15.00	5.00	-0.00000	0.00000	0.00000	0.00083	0.00001	-0.01206
-10.00	5.00	-0.00000	0.00000	0.00000	0.00074	0.00001	-0.01074
-5.00	5.00	-0.00000	0.00000	0.00000	0.00066	0.00000	-0.00957
0.00	5.00	0.00000	0.00000	-0.00000	0.00063	-0.00002	-0.00910
5.00	5.00	0.00000	0.00000	-0.00000	0.00065	-0.00004	-0.00945
10.00	5.00	0.00000	0.00000	-0.00000	0.00070	-0.00006	-0.01011
15.00	5.00	0.00000	0.00000	-0.00000	0.00074	-0.00009	-0.01075
20.00	5.00	0.00000	0.00000	-0.00000	0.00079	-0.00011	-0.01138

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	3.00	62000.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00082	0.00002	-0.01296
-15.00	5.00	0.00000	0.00000	0.00000	0.00072	0.00001	-0.01177
-10.00	5.00	0.00000	0.00000	0.00000	0.00060	0.00001	-0.01048
-5.00	5.00	0.00000	0.00000	0.00000	0.00054	0.00000	-0.00934
0.00	5.00	0.00000	0.00000	0.00000	0.00051	-0.00002	-0.00887
5.00	5.00	0.00000	0.00000	0.00000	0.00053	-0.00004	-0.00923
10.00	5.00	0.00000	0.00000	0.00000	0.00057	-0.00006	-0.00987
15.00	5.00	0.00000	0.00000	0.00000	0.00060	-0.00009	-0.01049
20.00	5.00	0.00000	0.00000	0.00000	0.00064	-0.00011	-0.01110

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	5.00	76000.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00081	0.00002	-0.011150
-15.00	5.00	0.00000	0.00000	0.00000	0.00070	0.00001	-0.010119
-10.00	5.00	0.00000	0.00000	0.00000	0.00061	0.00001	-0.009010
-5.00	5.00	0.00000	0.00000	0.00000	0.00049	0.00000	-0.008029
0.00	5.00	0.00000	0.00000	0.00000	0.00043	-0.00002	-0.007635
5.00	5.00	0.00000	0.00000	0.00000	0.00048	-0.00004	-0.007934
10.00	5.00	0.00000	0.00000	0.00000	0.00052	-0.00006	-0.008485
15.00	5.00	0.00000	0.00000	0.00000	0.00055	-0.00009	-0.009017
20.00	5.00	0.00000	0.00000	0.00000	0.00057	-0.00011	-0.009550

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	10.00	106000.00	0.	2979.55	34.00	0.00	-0.97
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00079	0.00003	-0.010119
-15.00	5.00	0.00000	0.00000	0.00000	0.00066	0.00003	-0.009024
-10.00	5.00	0.00000	0.00000	0.00000	0.00054	0.00002	-0.008007
-5.00	5.00	0.00000	0.00000	0.00000	0.00044	0.00000	-0.007208
0.00	5.00	0.00000	0.00000	0.00000	0.00037	-0.00002	-0.006808
5.00	5.00	0.00000	0.00000	0.00000	0.00038	-0.00004	-0.006854
10.00	5.00	0.00000	0.00000	0.00000	0.00039	-0.00007	-0.007171
15.00	5.00	0.00000	0.00000	0.00000	0.00041	-0.00009	-0.007611
20.00	5.00	0.00000	0.00099	-0.00000	0.00044	-0.00012	-0.008139

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG	
BASIC	16.00	140000.00	0.	2979.55	34.00	0.00	-0.97	
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE	
-20.00	5.00	0.00000	0.00000	0.00000	0.00077	0.00003	-0.009897	
-15.00	5.00	0.00000	0.00000	0.00000	0.00063	0.00003	-0.008749	
-10.00	5.00	0.00000	0.00000	0.00000	0.00051	0.00002	-0.007739	
-5.00	5.00	0.00000	0.00000	0.00000	0.00041	0.00000	-0.007023	
0.00	5.00	0.00000	0.00000	0.00000	0.00034	-0.00002	-0.006617	
5.00	5.00	0.00000	0.00000	0.00000	0.00033	-0.00005	-0.006534	
10.00	5.00	0.00000	0.00000	0.00000	0.00034	-0.00007	-0.006769	
15.00	5.00	0.00000	0.00000	0.00000	0.00036	-0.00009	-0.007198	
20.00	5.00	0.00000	0.00000	0.00000	0.00039	-0.00012	-0.007736	

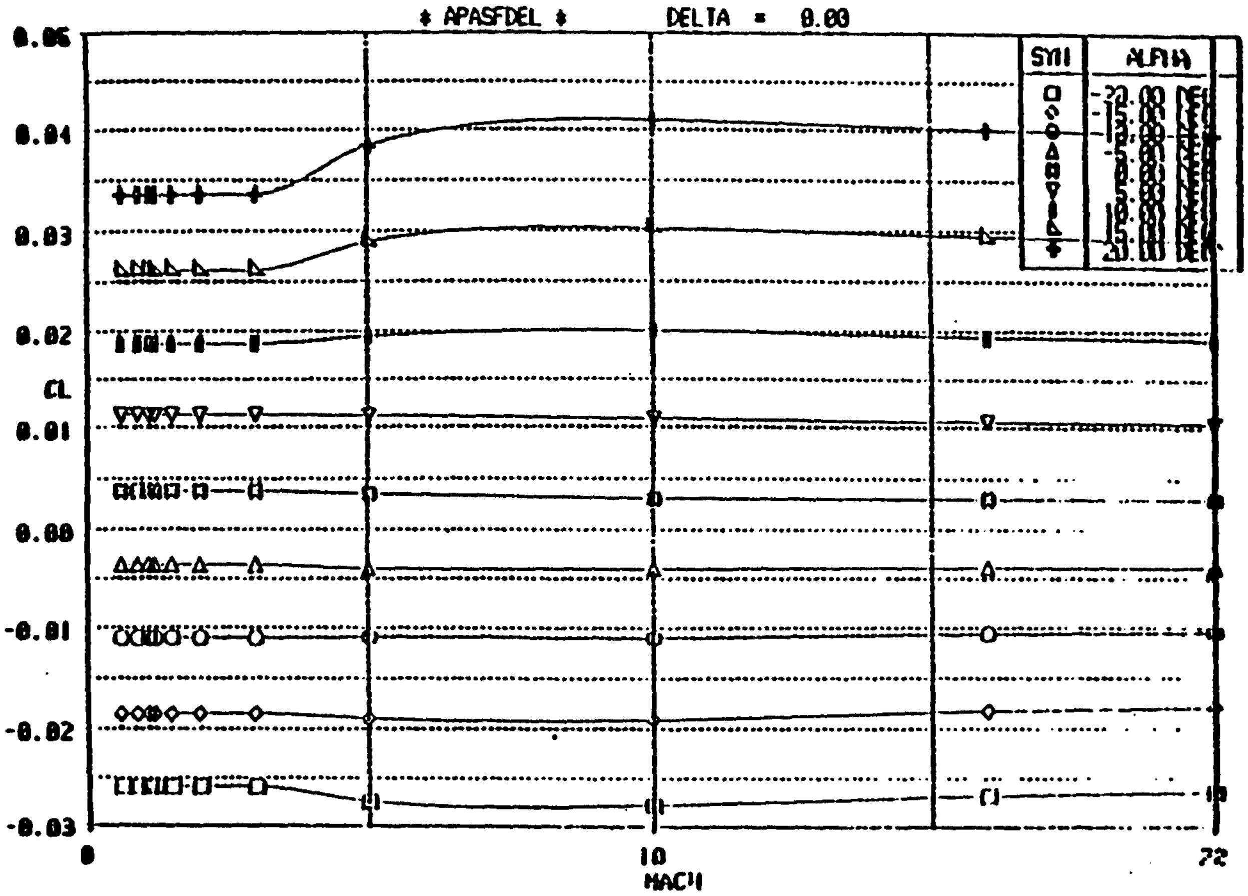
TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG	
BASIC	20.00	177000.00	0.	2979.55	34.00	0.00	-0.97	
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE	
-20.00	5.00	0.00000	0.00000	0.00000	0.00077	0.00003	-0.009857	
-15.00	5.00	0.00000	0.00000	0.00000	0.00063	0.00003	-0.008688	
-10.00	5.00	0.00000	0.00000	0.00000	0.00051	0.00002	-0.007672	
-5.00	5.00	0.00000	0.00000	0.00000	0.00041	0.00000	-0.006984	
0.00	5.00	0.00000	0.00000	0.00000	0.00035	-0.00002	-0.006576	
5.00	5.00	0.00000	0.00000	0.00000	0.00032	-0.00005	-0.006451	
10.00	5.00	0.00000	0.00000	0.00000	0.00033	-0.00007	-0.006670	
15.00	5.00	0.00000	0.00000	0.00000	0.00035	-0.00009	-0.007106	
20.00	5.00	0.00000	0.00000	0.00000	0.00038	-0.00012	-0.007652	

DYNAMIC DERIVATIVES

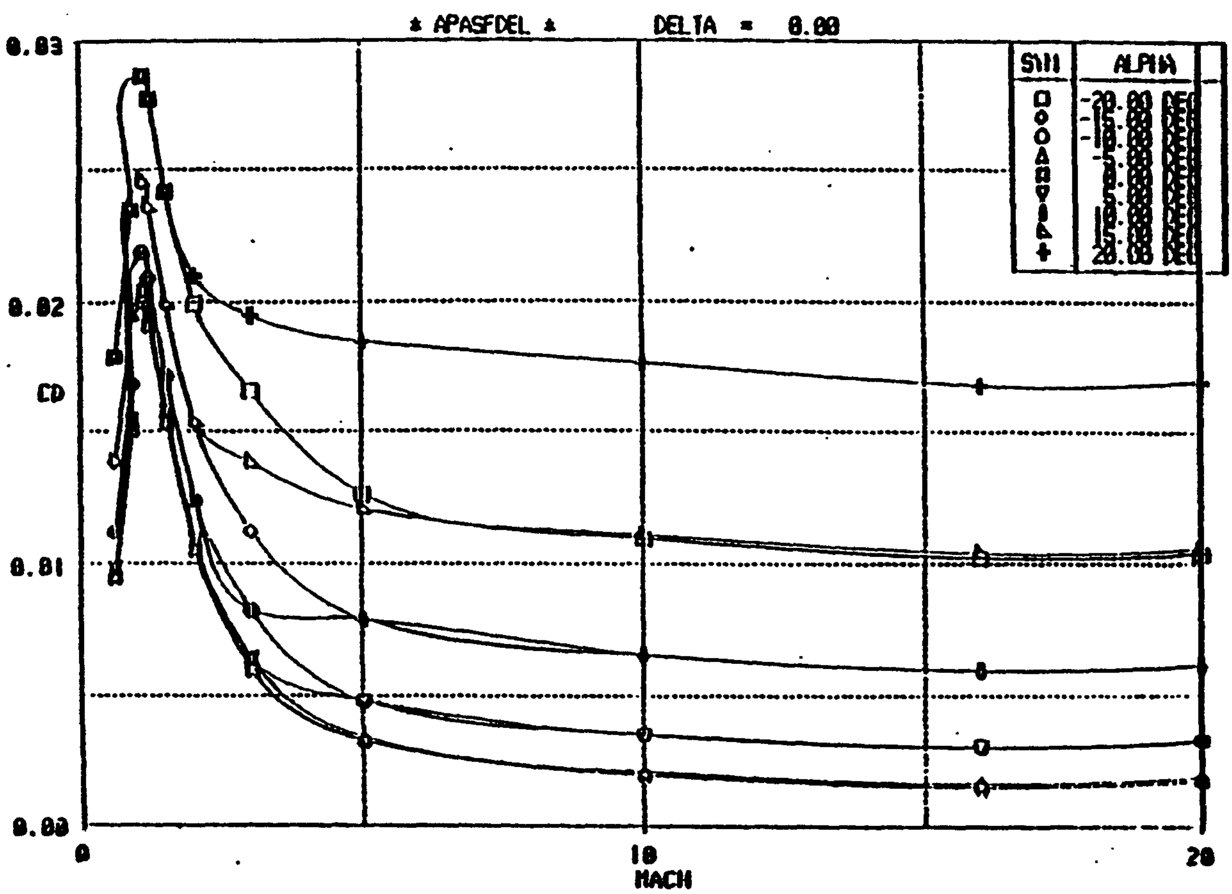
M	C_{Y_p}	C_{l_p}	C_{n_p}	C_{L_q}	C_{m_q}	C_{Y_r}	C_{l_r}	C_{n_r}
0.6	.00552	-.00009	-.00172	.04501	-.00825	.07574	-.00074	-.02269
0.9	.00611	-.00009	-.00191	.04533	-.00880	.08456	-.00082	-.02996
1.1	.00638	-.00010	-.00200	.04923	-.00943	.09602	-.00091	-.03447
1.2	.00632	-.00010	-.00203	.05021	-.00971	.09449	-.00091	-.03400
1.5	.00493	-.00010	-.00156	.04755	-.00947	.08516	-.00090	-.03267
2.0	.00415	-.00009	-.00134	.04446	-.00911	.06973	-.00079	-.02531
3.0	.00291	-.00008	-.00094	.03109	-.00817	.04310	-.00051	-.01569
5.0	.00153	-.00004	-.00073	.02137	-.00454	.01960	-.00033	-.00707
10.0	.00077	-.00002	-.00037	.01071	-.00208	.00476	-.00017	-.00347
16.0	.00056	-.00001	-.00033	.00773	-.00149	.00732	-.00012	-.00247
20.0	.00042	-.00001	-.00021	.00574	-.00109	.00519	-.00009	-.00181

Note: All derivatives are per unit rotation (rad/sec)

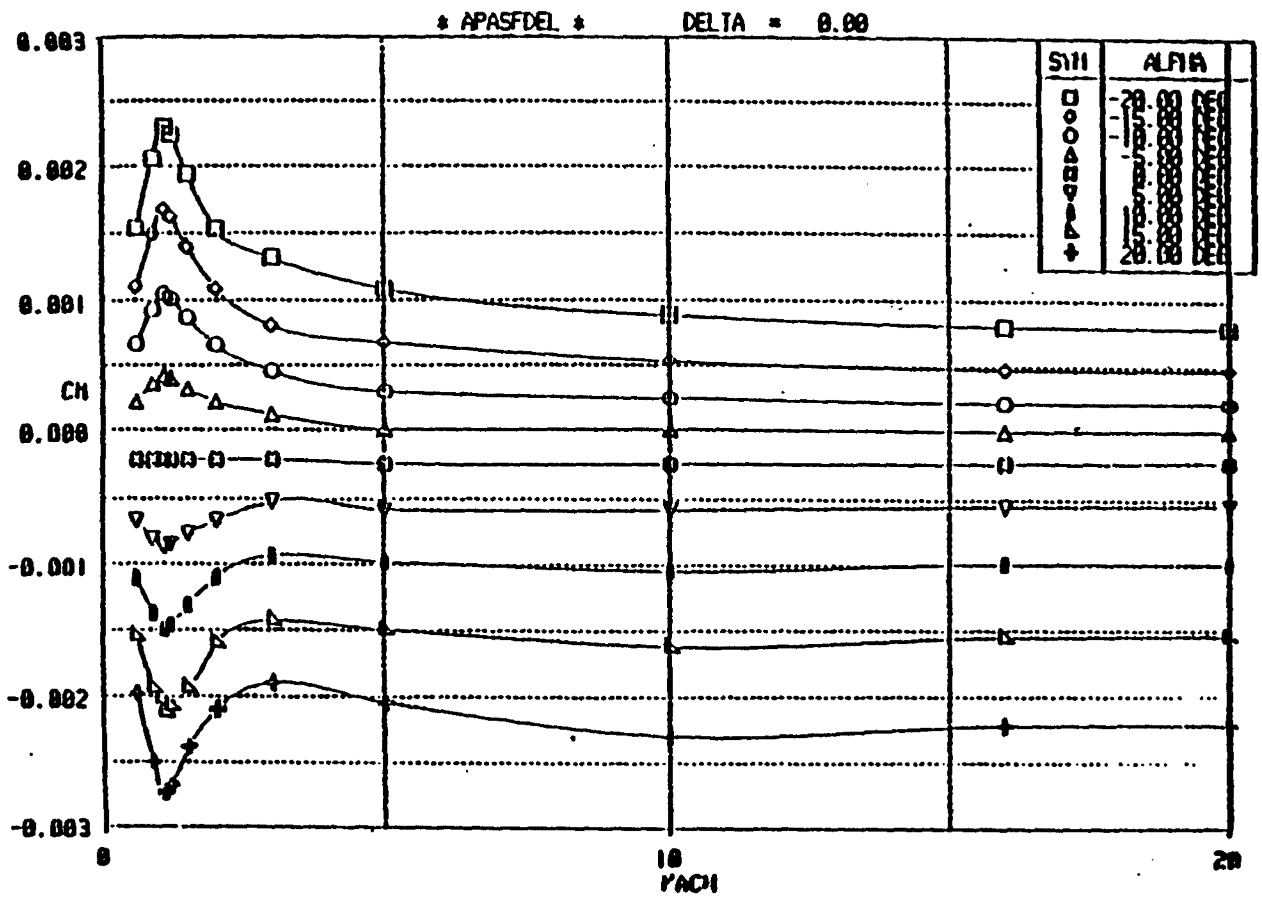
LIFT COEFFICIENT VERSUS MACH NUMBER



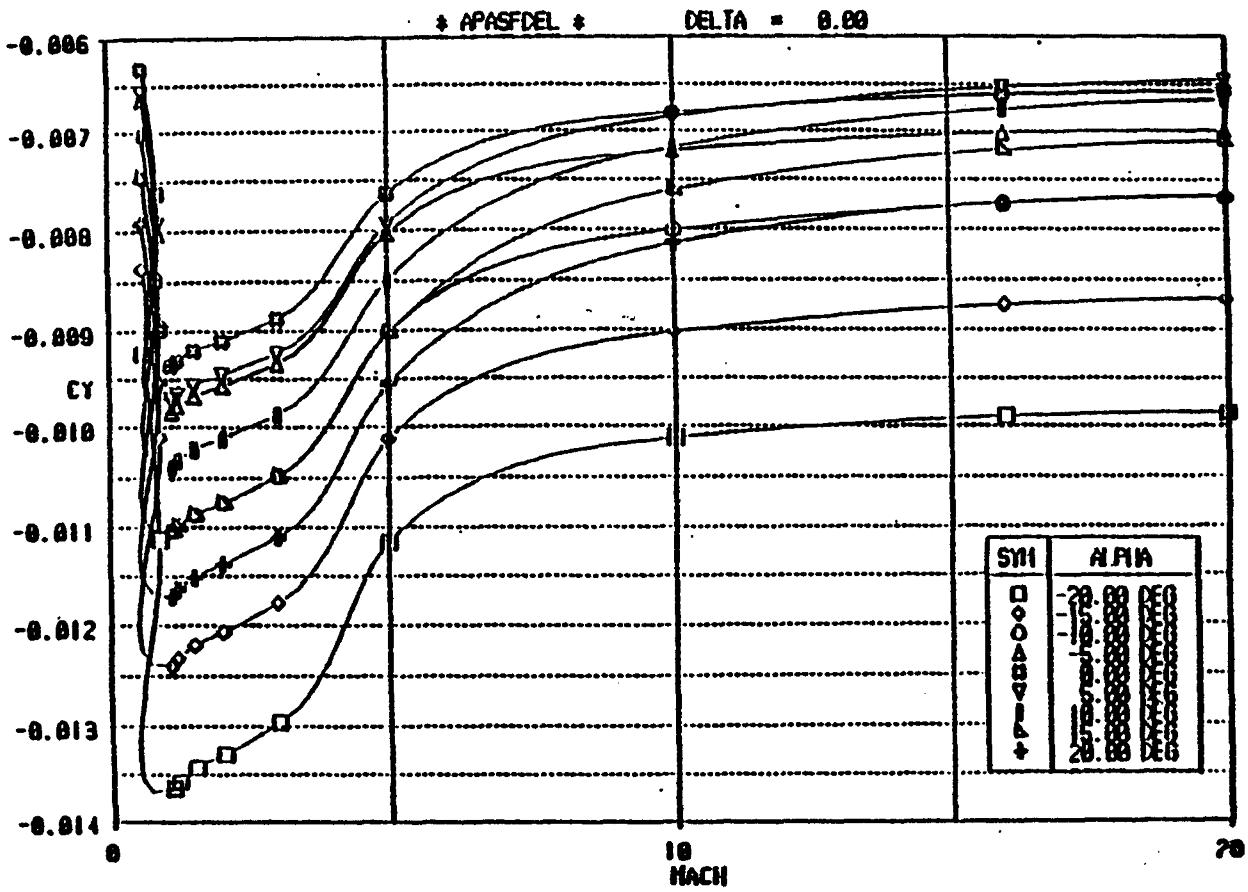
DRAG COEFFICIENT VERSUS MACH NUMBER



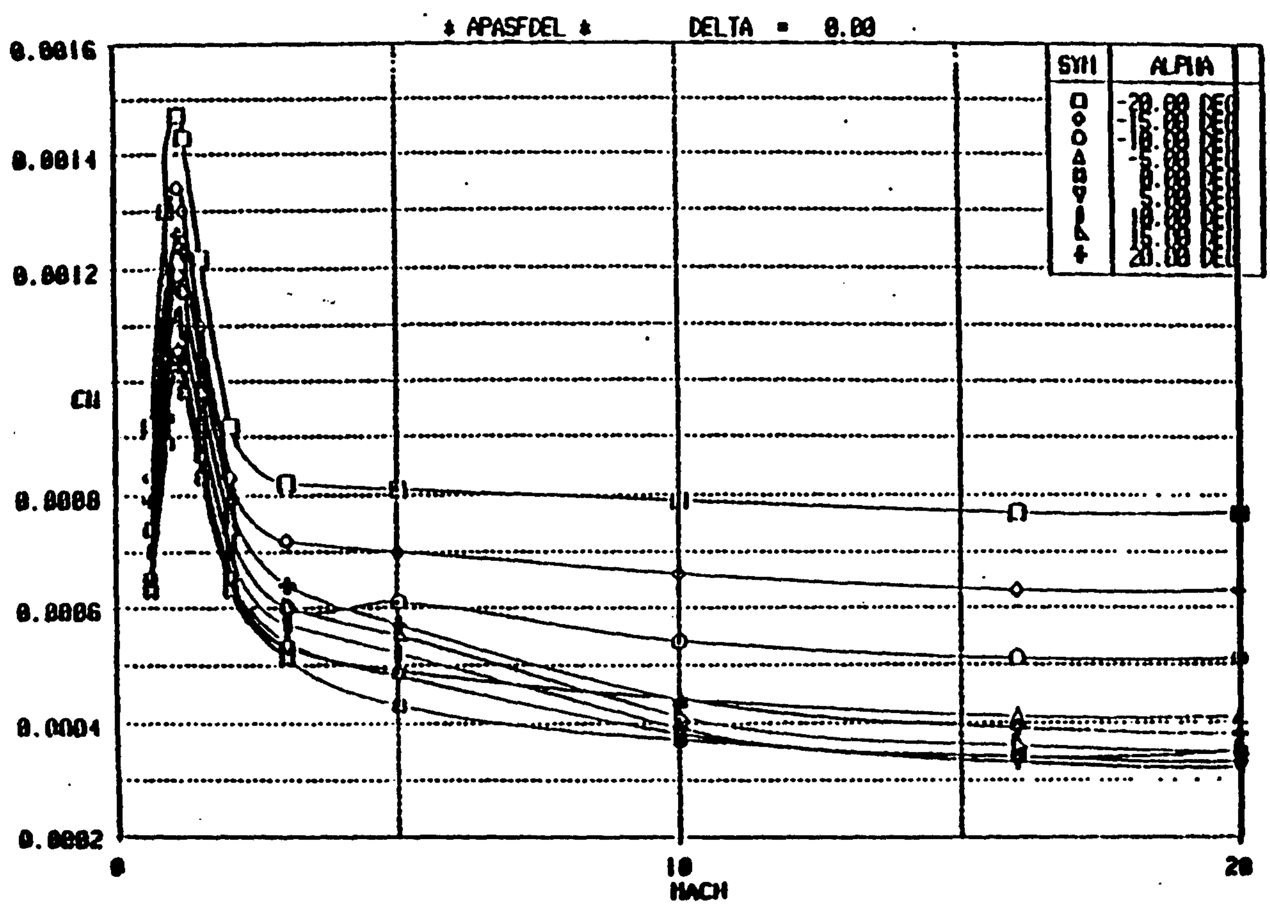
PITCHING MOMENT COEFFICIENT VERSUS MACH NUMBER



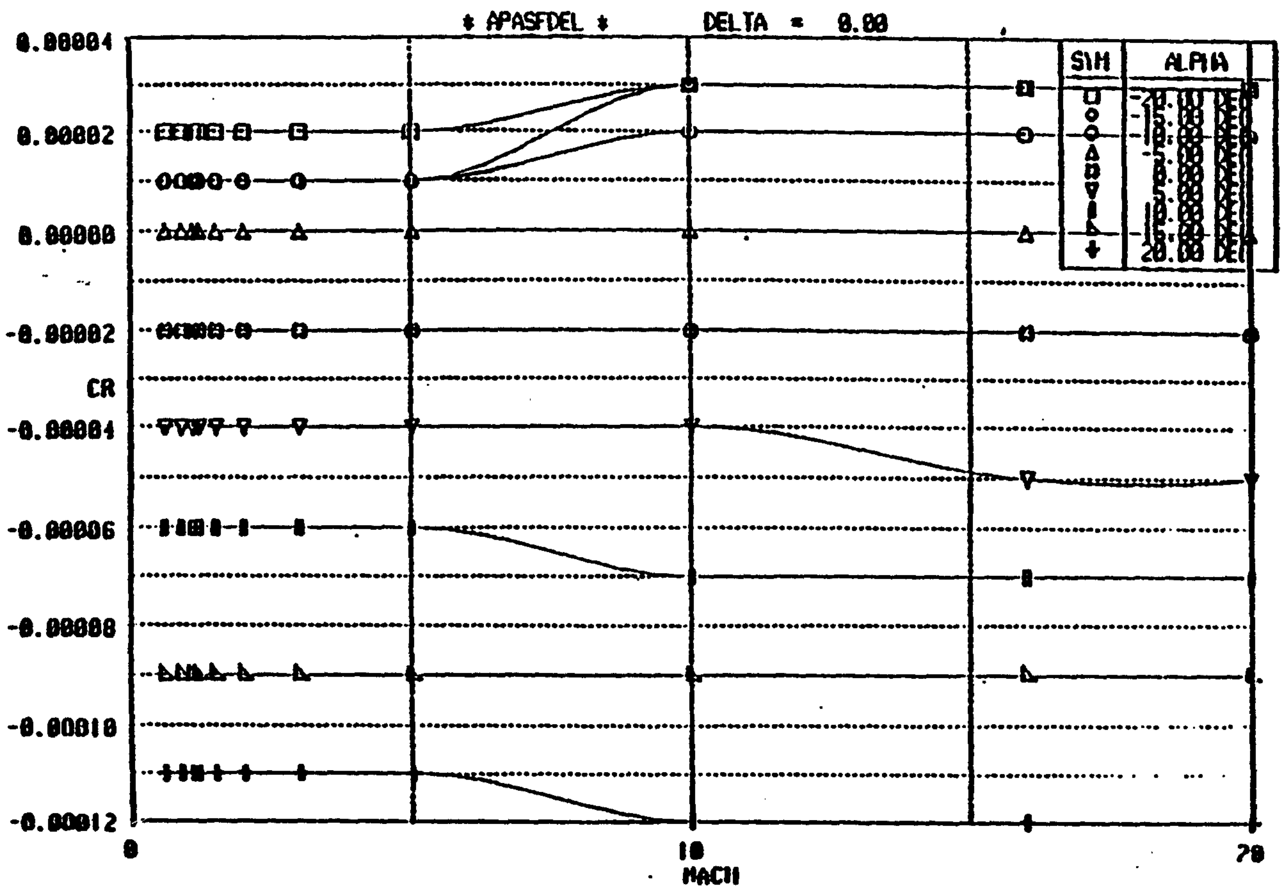
SIDE FORCE COEFFICIENT VERSUS MACH NUMBER, BETA=5

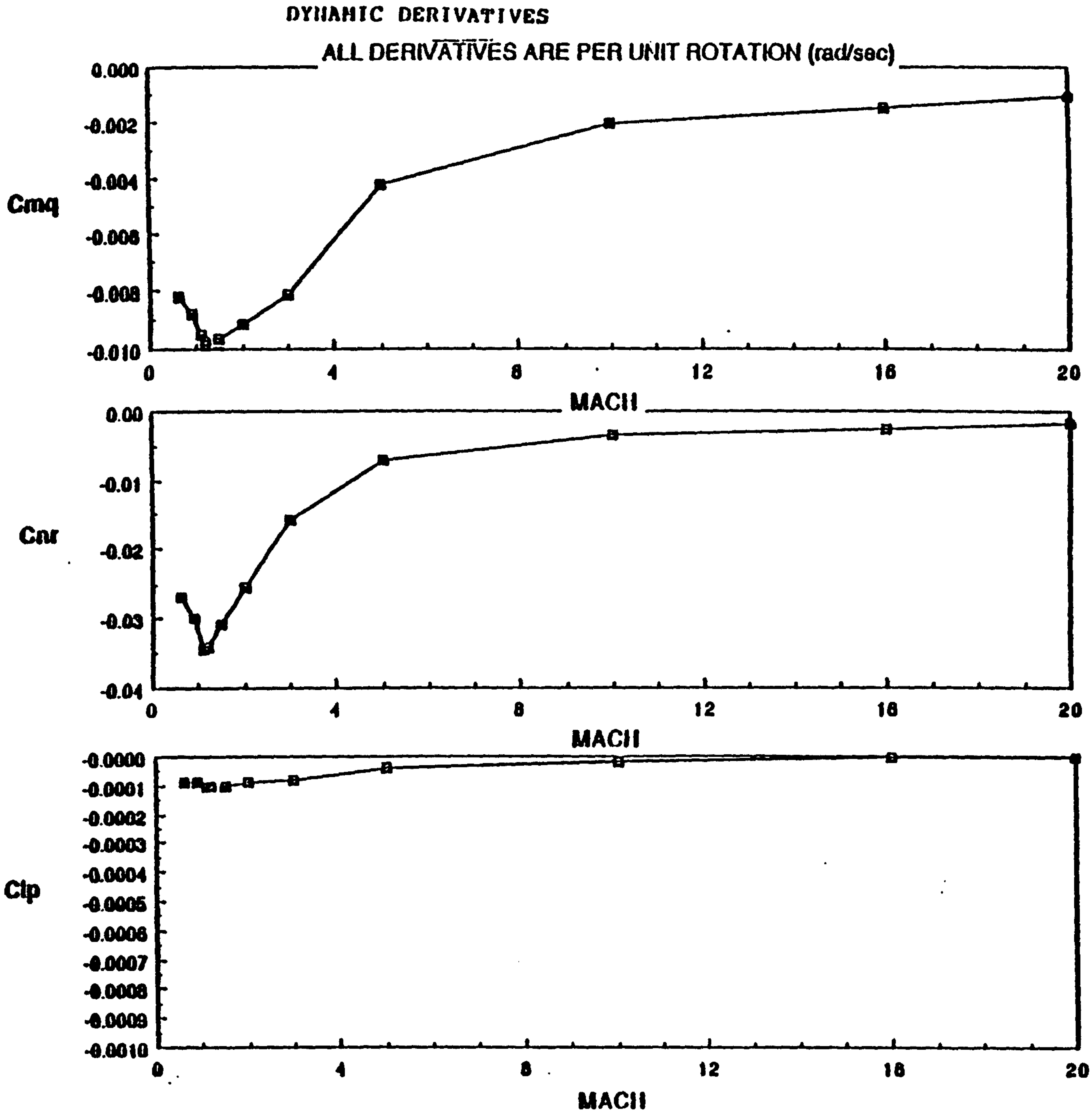


YAWING MOMENT COEFFICIENT VERSUS MACH NUMBER, BETA=5

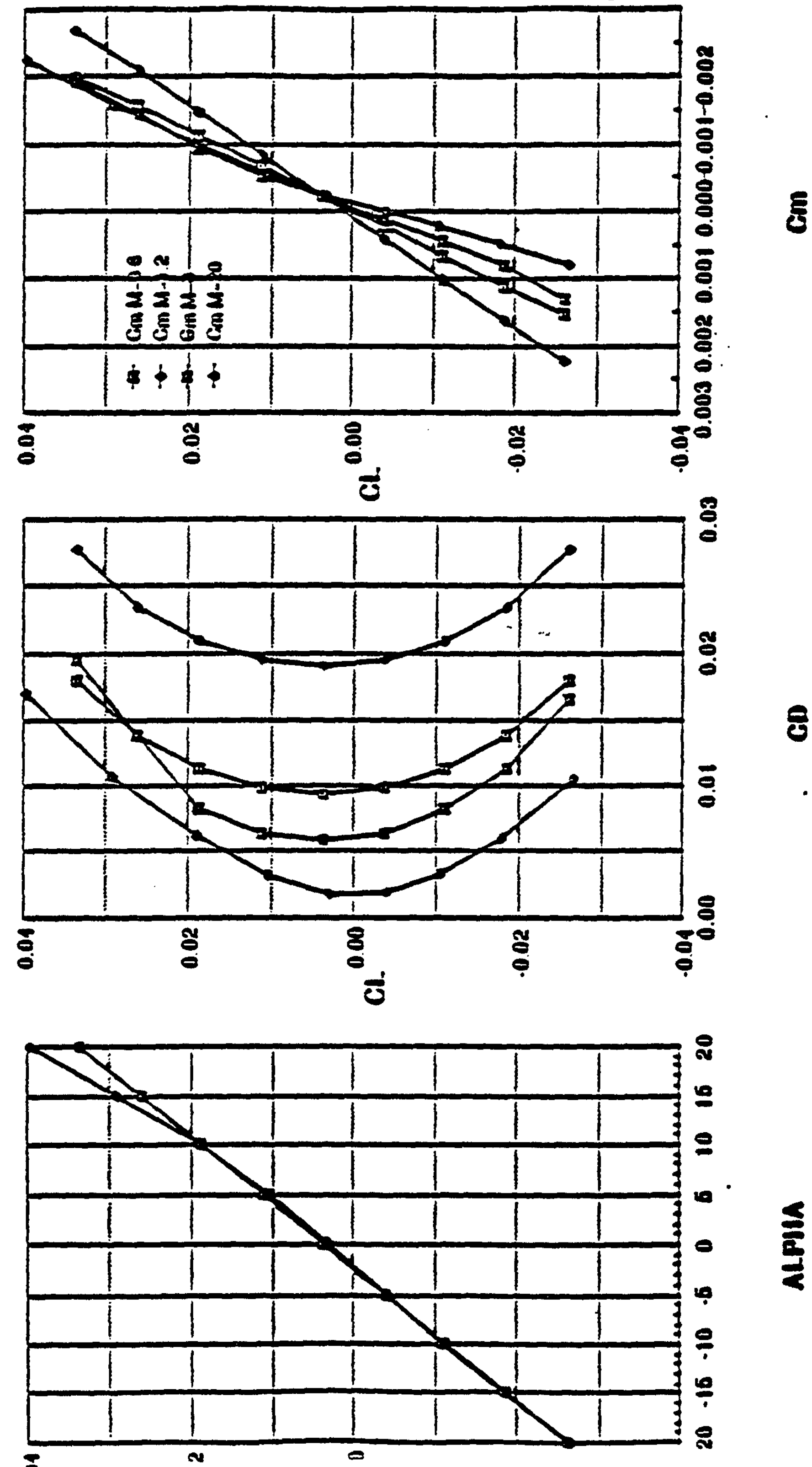


ROLLING MOMENT COEFFICIENT VERSUS MACH NUMBER, BETA=5

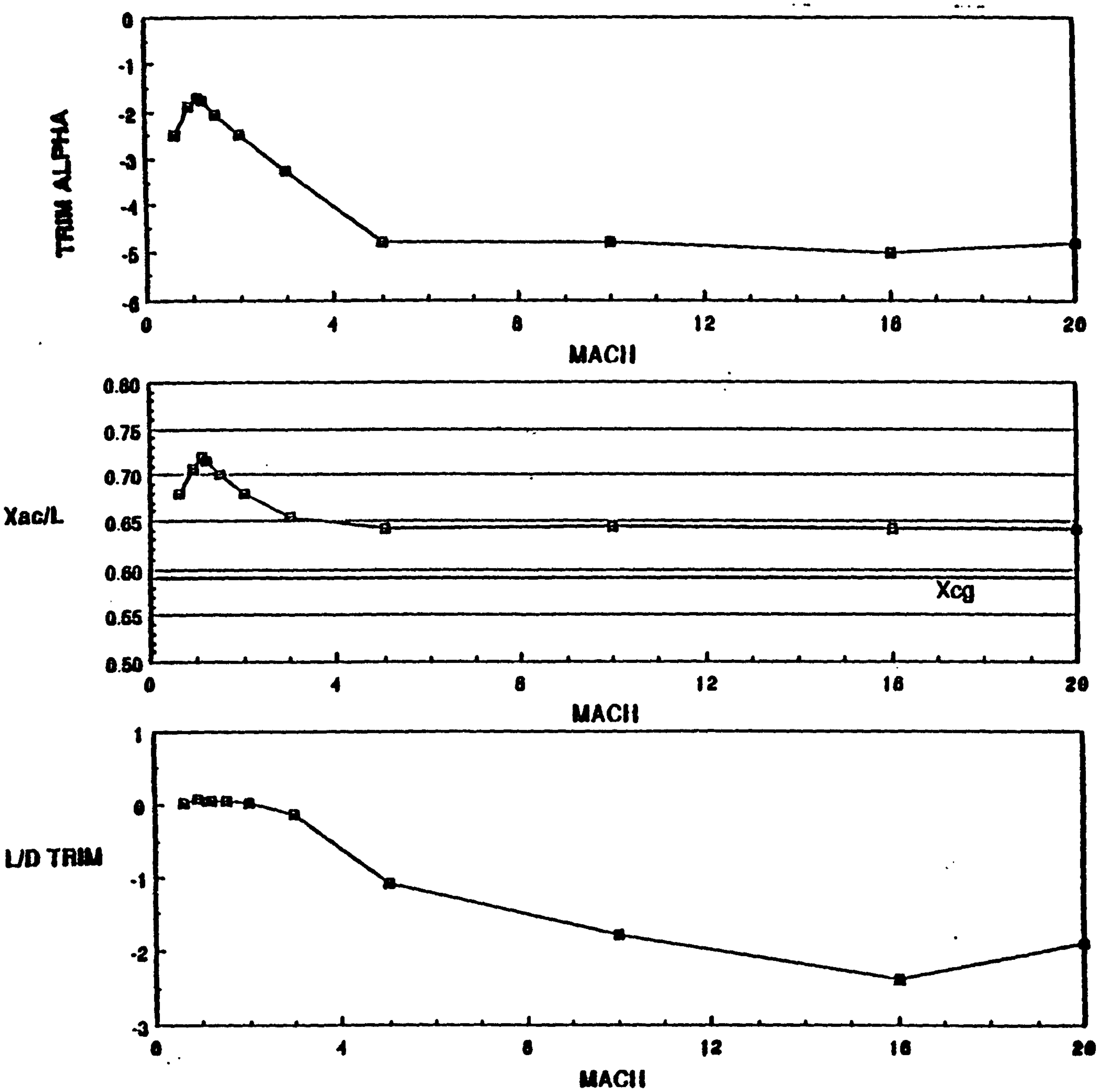


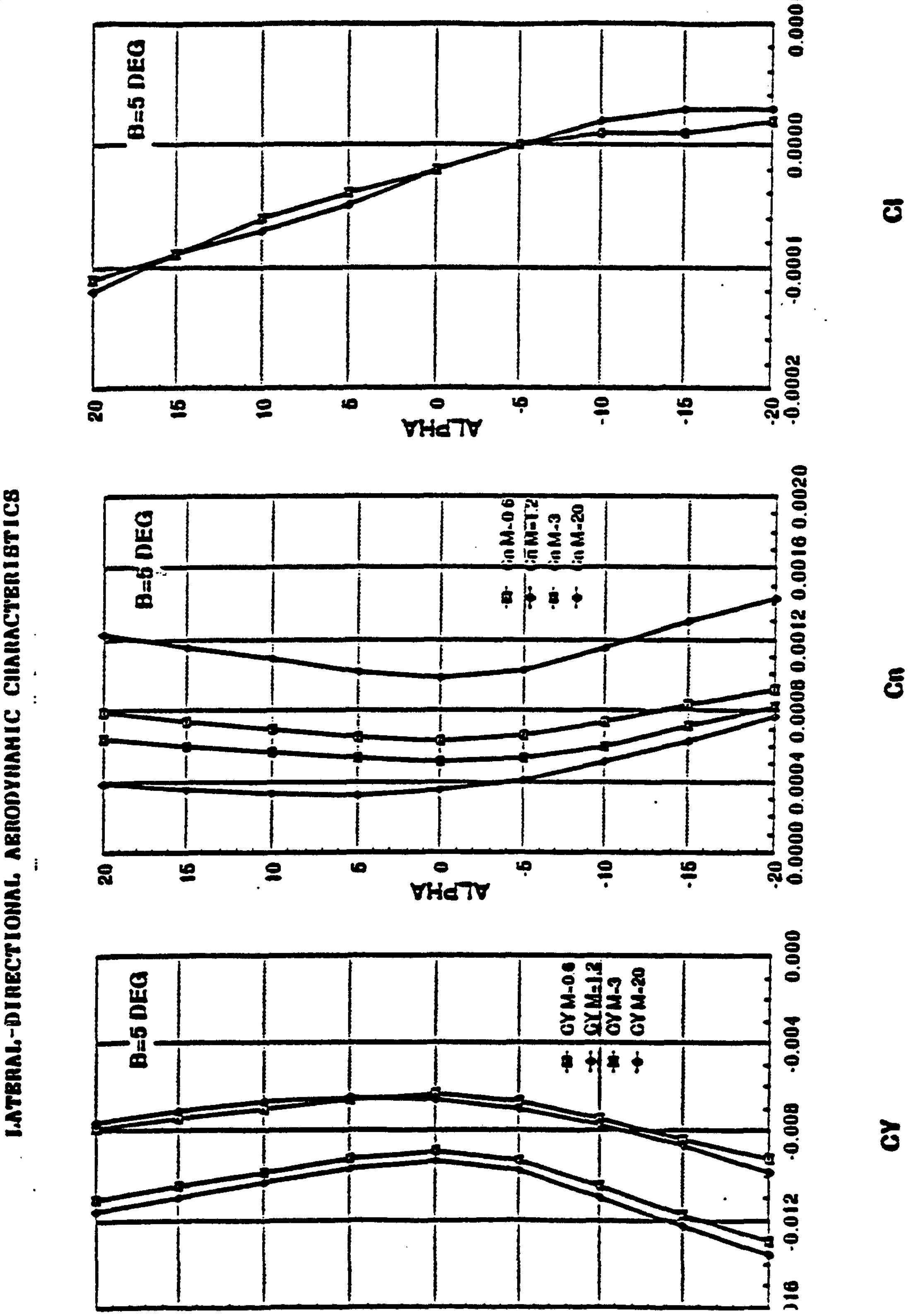

DYNAMIC DERIVATIVES
ALL DERIVATIVES ARE PER UNIT ROTATION (rad/sec)
Cmq
0.000
-0.002
-0.004
-0.006
-0.008
-0.010
0
4
8
12
16
20
MACH
Cnr
0.00
-0.01
-0.02
-0.03
-0.04
MACH
Clp
-0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
-0.0009
-0.0010
MACH

LONGITUDINAL AERODYNAMIC CHARACTERISTICS



STATIC STABILITY AND PERFORMANCE CHARACTERISTICS





LATERAL-DIRECTIONAL AERODYNAMIC CHARACTERISTICS
B=5 DEG
CY M=0.6
CY M=1.2
CY M=3
CY M=20
CY
Cn M=0.6
Cn M=1.2
Cn M=3
Cn M=20
Cn
Cl
ALPHA

LONGITUDINAL AERO FOR CREW ESCAPE SYSTEM

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.60	32000.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02319	0.01589	0.00199	-1.45941	-0.08446	0.001325
-15.00	0.00	-0.01656	0.01230	0.00143	-1.34634	-0.08308	0.001324
-10.00	0.00	-0.00994	0.01000	0.00088	-0.99400	-0.08597	0.001325
-5.00	0.00	-0.00331	0.00877	0.00031	-0.37742	-0.08610	0.001324
0.00	0.00	0.00331	0.00840	-0.00025	0.39405	-0.08597	0.001325
5.00	0.00	0.00994	0.00877	-0.00083	1.13341	-0.08597	0.001325
10.00	0.00	0.01657	0.01000	-0.00140	1.65700	-0.08459	0.001324
15.00	0.00	0.02319	0.01230	-0.00196	1.88537	-0.08296	0.001325
20.00	0.00	0.02982	0.01589	-0.00251	1.87665	-0.08296	0.001325

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.90	37000.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02319	0.02084	0.00246	-1.11276	-0.09970	0.001324
-15.00	0.00	-0.01657	0.01725	0.00180	-0.96058	-0.10407	0.001326
-10.00	0.00	-0.00994	0.01495	0.00111	-0.66488	-0.10256	0.001325
-5.00	0.00	-0.00331	0.01372	0.00043	-0.24125	-0.10423	0.001324
0.00	0.00	0.00331	0.01335	-0.00025	0.24794	-0.10407	0.001325
5.00	0.00	0.00994	0.01372	-0.00095	0.72449	-0.10256	0.001325
10.00	0.00	0.01657	0.01495	-0.00163	1.10836	-0.10407	0.001325
15.00	0.00	0.02320	0.01725	-0.00232	1.34493	-0.10121	0.001324
20.00	0.00	0.02982	0.02084	-0.00299	1.43090	-0.10121	0.001324

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.10	39000.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02327	0.02539	0.00269	-0.91650	-0.11011	0.001325
-15.00	0.00	-0.01664	0.02175	0.00196	-0.76506	-0.11027	0.001324
-10.00	0.00	-0.01002	0.01944	0.00123	-0.51543	-0.11312	0.001325
-5.00	0.00	-0.00339	0.01821	0.00048	-0.18616	-0.11161	0.001325
0.00	0.00	0.00324	0.01784	-0.00025	0.18161	-0.11011	0.001325
5.00	0.00	0.00987	0.01821	-0.00099	0.54201	-0.11312	0.001325
10.00	0.00	0.01650	0.01944	-0.00174	0.84877	-0.11027	0.001324
15.00	0.00	0.02312	0.02175	-0.00247	1.06299	-0.11011	0.001325
20.00	0.00	0.02975	0.02539	-0.00320	1.17172	-0.11011	0.001326

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.20	41500.00	0.	2979.55	29.50	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02327	0.02458	0.00262	-0.94670	-0.10709	0.001325
-15.00	0.00	-0.01664	0.02092	0.00191	-0.79541	-0.10725	0.001324
-10.00	0.00	-0.01002	0.01860	0.00120	-0.53871	-0.11011	0.001325
-5.00	0.00	-0.00339	0.01737	0.00047	-0.19516	-0.11011	0.001325
0.00	0.00	0.00324	0.01700	-0.00025	0.19059	-0.11011	0.001325
5.00	0.00	0.00987	0.01737	-0.00099	0.56822	-0.11011	0.001328
10.00	0.00	0.01650	0.01860	-0.00172	0.88710	-0.10574	0.001324
15.00	0.00	0.02312	0.02092	-0.00242	1.10516	-0.10860	0.001328
20.00	0.00	0.02975	0.02458	-0.00314	1.21033	-0.10860	0.001325

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.50	45500.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02326	0.02161	0.00237	-1.08547	-0.09789	0.001323
-15.00	0.00	-0.01660	0.01760	[illegible]	[illegible]	-0.09789	0.001323

-10.00	0.00	-0.00996	0.01525	0.00107	-0.65311	-0.10106	0.001326
-5.00	0.00	-0.00333	0.01402	0.00040	-0.23752	-0.09940	0.001328
0.00	0.00	0.00331	0.01365	-0.00025	0.24249	-0.09940	0.001328
5.00	0.00	0.00995	0.01402	-0.00092	0.70970	-0.10090	0.001328
10.00	0.00	0.01659	0.01525	-0.00159	1.08787	-0.09789	0.001323
15.00	0.00	0.02323	0.01760	-0.00224	1.31989	-0.09804	0.001325
20.00	0.00	0.02986	0.02141	-0.00289	1.39468	-0.09804	0.001325

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	2.00	53000.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02327	0.01760	0.00200	-1.32216	-0.08283	0.001328
-15.00	0.00	-0.01663	0.01339	0.00145	-1.24197	-0.08571	0.001330
-10.00	0.00	-0.00998	0.01097	0.00088	-0.90975	-0.08584	0.001328
-5.00	0.00	-0.00334	0.00973	0.00031	-0.34327	-0.08571	0.001330
0.00	0.00	0.00331	0.00936	-0.00025	0.35363	-0.08434	0.001328
5.00	0.00	0.00995	0.00973	-0.00082	1.02251	-0.08722	0.001330
10.00	0.00	0.01660	0.01097	-0.00140	1.51322	-0.09789	0.001323
15.00	0.00	0.02324	0.01339	-0.00205	1.73562	-0.08571	0.001330
20.00	0.00	0.02989	0.01840	-0.00252	1.62446	-0.08571	0.001330

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	3.00	62000.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02317	0.01378	0.00177	-1.68142	-0.08157	0.001324
-15.00	0.00	-0.01655	0.00960	0.00123	-1.72396	-0.08157	0.001324
-10.00	0.00	-0.00993	0.00693	0.00069	-1.43290	-0.07240	0.001326
-5.00	0.00	-0.00330	0.00566	0.00021	-0.58304	-0.07100	0.001324
0.00	0.00	0.00332	0.00529	-0.00026	0.62760	-0.07100	0.001324
5.00	0.00	0.00994	0.00566	-0.00073	1.75618	-0.08610	0.001324
10.00	0.00	0.01656	0.00693	-0.00130	2.38961	-0.09063	0.001324
15.00	0.00	0.02318	0.01160	-0.00190	1.99828	-0.08308	0.001324
20.00	0.00	0.02980	0.01710	-0.00245	1.74269	-0.08308	0.001324

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	5.00	76000.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02450	0.01135	0.00169	-2.15859	-0.07673	0.001564
-15.00	0.00	-0.01668	0.00694	0.00109	-2.40346	-0.08234	0.001336
-10.00	0.00	-0.01000	0.00425	0.00054	-2.35294	-0.06505	0.001322
-5.00	0.00	-0.00339	0.00306	0.00011	-1.10784	-0.06646	0.001294
0.00	0.00	0.00308	0.00292	-0.00032	1.05479	-0.06214	0.001384
5.00	0.00	0.01000	0.00425	-0.00075	2.35294	-0.08029	0.001370
10.00	0.00	0.01685	0.00694	-0.00130	2.42795	-0.09112	0.001690
15.00	0.00	0.02530	0.01080	-0.00207	2.34259	-0.08902	0.001640
20.00	0.00	0.03350	0.01620	-0.00280	2.06790	-0.08902	0.001640

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	10.00	106000.00	0.	2979.55	29.60	-0.85	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02466	0.00986	0.00142	-2.50101	-0.06789	0.001532
-15.00	0.00	-0.01700	0.00575	0.00090	-2.95652	-0.06171	0.001426
-10.00	0.00	-0.00987	0.00316	0.00046	-3.12342	-0.05742	0.001254
-5.00	0.00	-0.00360	0.00187	0.00010	-1.92513	-0.05864	0.001262
0.00	0.00	0.00271	0.00175	-0.00027	1.54857	-0.06745	0.001364
5.00	0.00	0.00953	0.00309	-0.00073	3.08414	-0.07444	0.001612
10.00	0.00	0.01739	0.00538	-0.00133	3.25952	-0.08287	0.001786
15.00	0.00	0.02652	0.00995	-0.00207	2.66533	-0.09062	0.001876
20.00	0.00	0.03590	0.01[illegible]	-0.002[illegible]	2.12362	-0.09062	0.001876

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	16.00	140000.00	0.	2979.55	29.60	-0.85	0.00

ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02377	0.00918	0.00133	-2.58932	-0.06667	0.001500
-15.00	0.00	-0.01627	0.00523	0.00083	-3.11090	-0.05926	0.001350
-10.00	0.00	-0.00952	0.00276	0.00043	-3.44928	-0.05676	0.001198
-5.00	0.00	-0.00353	0.00149	0.00009	-2.36913	-0.05663	0.001236
0.00	0.00	0.00265	0.00136	-0.00026	1.94853	-0.06495	0.001326
5.00	0.00	0.00927	0.00290	-0.00069	3.19655	-0.07513	0.001544
10.00	0.00	0.01699	0.00491	-0.00127	3.46028	-0.08096	0.001754
15.00	0.00	0.02576	0.00933	-0.00198	2.76099	-0.09081	0.001872
20.00	0.00	0.03512	0.01471	-0.00283	2.38749	-0.09081	0.001872

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	20.00	177000.00	0.	2979.55	29.60	-0.85	0.00

ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02344	0.00935	0.00132	-2.50695	-0.06720	0.001488
-15.00	0.00	-0.01600	0.00541	0.00082	-2.95749	-0.05891	0.001324
-10.00	0.00	-0.00938	0.00297	0.00043	-3.15825	-0.05612	0.001176
-5.00	0.00	-0.00350	0.00171	0.00010	-2.04678	-0.05873	0.001226
0.00	0.00	0.00263	0.00159	-0.00026	1.65409	-0.06432	0.001306
5.00	0.00	0.00916	0.00290	-0.00068	3.15862	-0.07632	0.001520
10.00	0.00	0.01676	0.00509	-0.00126	3.29273	-0.08161	0.001740
15.00	0.00	0.02546	0.00949	-0.00197	2.68282	-0.09110	0.001866
20.00	0.00	0.03479	0.01487	-0.00282	2.33961	-0.09110	0.001866

LATERAL-DIRECTIONAL AERO FOR CREW ESCAPE, BETA=5

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.80	32000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00124	0.00002	-0.00820
-15.00	5.00	-0.00000	0.00000	0.00000	0.00113	0.00001	-0.00745
-10.00	5.00	-0.00000	0.00000	0.00000	0.00101	0.00000	-0.00666
-5.00	5.00	-0.00000	0.00000	0.00000	0.00090	0.00000	-0.00595
0.00	5.00	0.00000	0.00000	-0.00000	0.00086	-0.00001	-0.00567
5.00	5.00	0.00000	0.00000	-0.00000	0.00089	-0.00003	-0.00588
10.00	5.00	0.00000	0.00000	-0.00000	0.00095	-0.00005	-0.00629
15.00	5.00	0.00000	0.00000	-0.00000	0.00101	-0.00006	-0.00668
20.00	5.00	0.00000	0.00000	-0.00000	0.00108	-0.00008	-0.00709

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.90	37000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00158	0.00002	-0.00990
-15.00	5.00	-0.00000	0.00000	0.00000	0.00143	0.00001	-0.00899
-10.00	5.00	-0.00000	0.00000	0.00000	0.00128	0.00000	-0.00803
-5.00	5.00	-0.00000	0.00000	0.00000	0.00114	0.00000	-0.00718
0.00	5.00	0.00000	0.00000	-0.00000	0.00109	-0.00001	-0.00684
5.00	5.00	0.00000	0.00000	-0.00000	0.00113	-0.00003	-0.00709
10.00	5.00	0.00000	0.00000	-0.00000	0.00121	-0.00005	-0.00759
15.00	5.00	0.00000	0.00000	-0.00000	0.00128	-0.00006	-0.00806
20.00	5.00	0.00000	0.00000	-0.00000	0.00136	-0.00008	-0.00855

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.10	39000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00174	0.00002	-0.01214
-15.00	5.00	-0.00000	0.00000	0.00000	0.00158	0.00001	-0.01103
-10.00	5.00	-0.00000	0.00000	0.00000	0.00141	0.00000	-0.00985
-5.00	5.00	-0.00000	0.00000	0.00000	0.00126	0.00000	-0.00880
0.00	5.00	0.00000	0.00000	-0.00000	0.00120	-0.00001	-0.00839
5.00	5.00	0.00000	0.00000	-0.00000	0.00124	-0.00003	-0.00870
10.00	5.00	0.00000	0.00000	-0.00000	0.00133	-0.00005	-0.00931
15.00	5.00	0.00000	0.00000	-0.00000	0.00141	-0.00006	-0.00989
20.00	5.00	0.00000	0.00000	-0.00000	0.00150	-0.00008	-0.01049

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.20	41500.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00169	0.00002	-0.01207
-15.00	5.00	-0.00000	0.00000	0.00000	0.00154	0.00001	-0.01079
-10.00	5.00	-0.00000	0.00000	0.00000	0.00137	0.00000	-0.00979
-5.00	5.00	-0.00000	0.00000	0.00000	0.00123	0.00000	-0.00875
0.00	5.00	0.00000	0.00000	-0.00000	0.00117	-0.00001	-0.00834
5.00	5.00	0.00000	0.00000	-0.00000	0.00121	-0.00003	-0.00865
10.00	5.00	0.00000	0.00000	-0.00000	0.00130	-0.00005	-0.00926
15.00	5.00	0.00000	0.00000	-0.00000	0.00138	-0.00006	-0.00983
20.00	5.00	0.00000	0.00000	-0.00000	0.00146	-0.00008	-0.01042

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.50	45500.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00151	0.00002	-0.01194

-10.00	5.00	-0.00000	0.00000	0.00000	0.00122	0.00000	-0.00968
-5.00	5.00	-0.00000	0.00000	0.00000	0.00109	0.00000	-0.00865
0.00	5.00	0.00000	0.00000	-0.00000	0.00104	-0.00001	-0.00825
5.00	5.00	0.00000	0.00000	-0.00000	0.00108	-0.00003	-0.00856
10.00	5.00	0.00000	0.00000	-0.00000	0.00115	-0.00005	-0.00916
15.00	5.00	0.00000	0.00000	-0.00000	0.00123	-0.00006	-0.00973
20.00	5.00	0.00000	0.00000	-0.00000	0.00130	-0.00008	-0.01031

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	2.00	53000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	0.00000	0.00000	0.00000	0.00123	0.00002	-0.01181
-15.00	5.00	-0.00000	0.00000	0.00000	0.00112	0.00001	-0.01073
-10.00	5.00	-0.00000	0.00000	0.00000	0.00100	0.00000	-0.00958
-5.00	5.00	-0.00000	0.00000	0.00000	0.00089	0.00000	-0.00856
0.00	5.00	0.00000	0.00000	-0.00000	0.00085	-0.00001	-0.00816
5.00	5.00	0.00000	0.00000	-0.00000	0.00088	-0.00003	-0.00846
10.00	5.00	0.00000	0.00000	-0.00000	0.00094	-0.00005	-0.00906
15.00	5.00	0.00000	0.00000	-0.00000	0.00100	-0.00006	-0.00962
20.00	5.00	0.00000	0.00000	-0.00000	0.00106	-0.00008	-0.01020

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	3.00	62000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00115	0.00002	-0.01152
-15.00	5.00	-0.00000	0.00000	0.00000	0.00104	0.00001	-0.01047
-10.00	5.00	-0.00000	0.00000	0.00000	0.00090	0.00000	-0.00935
-5.00	5.00	-0.00000	0.00000	0.00000	0.00081	0.00000	-0.00825
0.00	5.00	0.00000	0.00000	-0.00000	0.00077	-0.00001	-0.00796
5.00	5.00	0.00000	0.00000	-0.00000	0.00080	-0.00003	-0.00825
10.00	5.00	0.00000	0.00000	-0.00000	0.00086	-0.00005	-0.00884
15.00	5.00	0.00000	0.00000	-0.00000	0.00091	-0.00006	-0.00938
20.00	5.00	0.00000	0.00000	-0.00000	0.00096	-0.00008	-0.00995

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	5.00	76000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00111	0.00002	-0.009811
-15.00	5.00	-0.00000	0.00000	0.00000	0.00099	0.00001	-0.008918
-10.00	5.00	-0.00000	0.00000	0.00000	0.00090	0.00001	-0.007959
-5.00	5.00	-0.00000	0.00000	0.00000	0.00076	0.00000	-0.007113
0.00	5.00	0.00000	0.00000	-0.00000	0.00069	-0.00001	-0.006782
5.00	5.00	0.00000	0.00000	-0.00000	0.00074	-0.00003	-0.007034
10.00	5.00	0.00000	0.00000	-0.00000	0.00080	-0.00005	-0.007525
15.00	5.00	0.00000	0.00000	-0.00000	0.00085	-0.00007	-0.007999
20.00	5.00	0.00000	0.00000	-0.00000	0.00089	-0.00008	-0.008476

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	10.00	106000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00109	0.00003	-0.008897
-15.00	5.00	-0.00000	0.00000	0.00000	0.00094	0.00002	-0.007953
-10.00	5.00	-0.00000	0.00000	0.00000	0.00079	0.00002	-0.007077
-5.00	5.00	-0.00000	0.00000	0.00000	0.00068	0.00000	-0.006394
0.00	5.00	0.00000	0.00000	-0.00000	0.00061	-0.00001	-0.006056
5.00	5.00	0.00000	0.00000	-0.00000	0.00062	-0.00003	-0.006098
10.00	5.00	0.00000	0.00000	-0.00000	0.00064	-0.00005	-0.006383
15.00	5.00	0.00000	0.00000	-0.00000	0.00068	-0.00007	-0.006776
[illegible]	[illegible]	0.00000	[illegible]	[illegible]	[illegible]	-0.00009	-0.007267

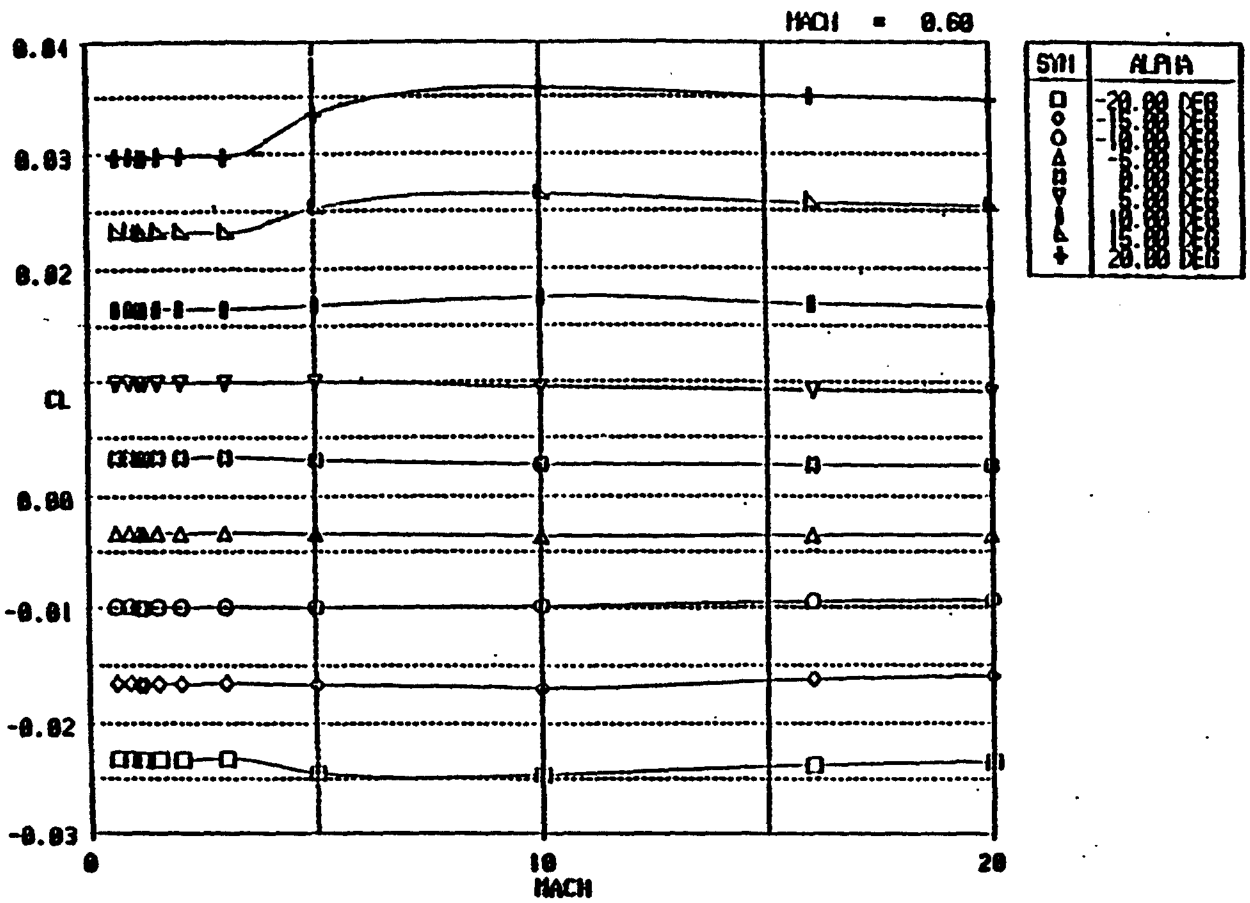
TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	16.00	140000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00106	0.00003	-0.008700
-15.00	5.00	-0.00000	0.00000	0.00000	0.00090	0.00003	-0.007710
-10.00	5.00	-0.00000	0.00000	0.00000	0.00076	0.00002	-0.006842
-5.00	5.00	-0.00000	0.00000	0.00000	0.00065	0.00000	-0.006233
0.00	5.00	0.00000	0.00000	-0.00000	0.00058	-0.00001	-0.005891
5.00	5.00	0.00000	0.00000	-0.00000	0.00056	-0.00003	-0.005823
10.00	5.00	0.00000	0.00000	-0.00000	0.00058	-0.00005	-0.006035
15.00	5.00	0.00000	0.00000	-0.00000	0.00062	-0.00007	-0.006420
20.00	5.00	0.00000	0.00000	-0.00000	0.00066	-0.00009	-0.006899

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	20.00	177000.00	0.	2979.55	29.60	0.00	-0.85
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00106	0.00003	-0.008664
-15.00	5.00	-0.00000	0.00000	0.00000	0.00090	0.00003	-0.007656
-10.00	5.00	-0.00000	0.00000	0.00000	0.00075	0.00002	-0.006783
-5.00	5.00	-0.00000	0.00000	0.00000	0.00065	0.00000	-0.006199
0.00	5.00	0.00000	0.00000	-0.00000	0.00058	-0.00001	-0.005856
5.00	5.00	0.00000	0.00000	-0.00000	0.00055	-0.00003	-0.005752
10.00	5.00	0.00000	0.00000	-0.00000	0.00057	-0.00005	-0.005950
15.00	5.00	0.00000	0.00000	-0.00000	0.00061	-0.00007	-0.006340
20.00	5.00	0.00000	0.00000	-0.00000	0.00065	-0.00009	-0.006826

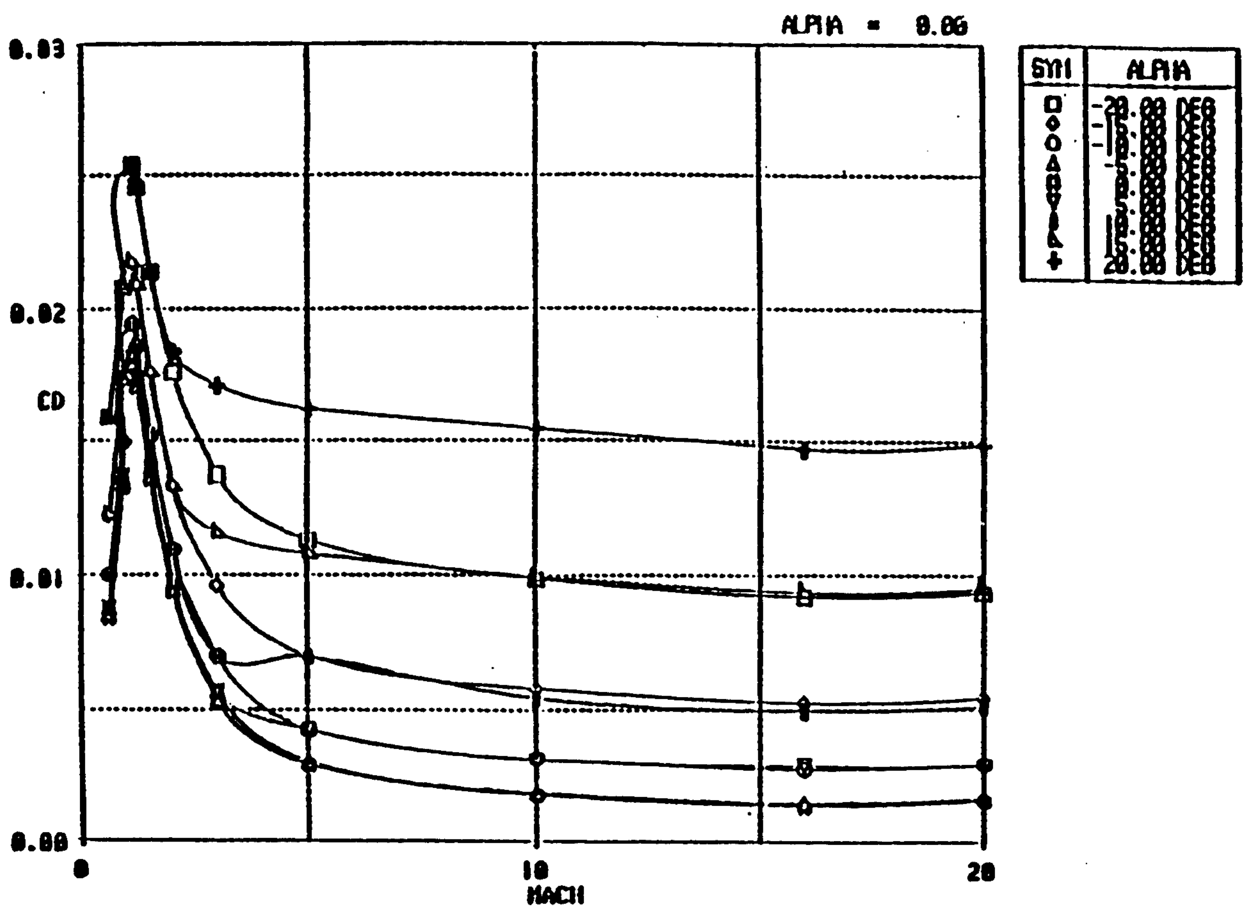
DYNAMIC DERIVATIVES

M	C_{Y_p}	C_{l_p}	C_{n_p}	C_{L_q}	C_{m_q}	C_{Y_r}	C_{l_r}	C_{n_r}
0.6	.00459	-.00006	-.00156	.04157	-.00767	.07023	-.00057	-.02480
0.9	.00508	-.00006	-.00173	.04574	-.00823	.07841	-.00066	-.02783
1.1	.00572	-.00007	-.00200	.04604	-.00883	.08904	-.00072	-.03203
1.2	.00525	-.00007	-.00184	.04640	-.00905	.08762	-.00073	-.03157
1.5	.00410	-.00006	-.00143	.04594	-.00901	.07887	-.00072	-.02250
2.0	.00545	-.00006	-.00121	.05831	-.00849	.06496	-.00063	-.02552
3.0	.00242	-.00006	-.00086	.02873	-.00761	.03997	-.00041	-.01458
5.0	.00127	-.00003	-.00067	.01976	-.00595	.01818	-.00026	-.01657
10.0	.00064	-.00001	-.00034	.00990	-.00194	.00905	-.00013	-.00323
15.0	.00047	-.00001	-.00025	.00715	-.00159	.00651	-.00009	-.00230
20.0	.00035	-.00001	-.00019	.00531	-.00102	.00481	-.00007	-.00168
	ALL DERIVATIVES ARE PER UNIT ROTATION (rad/sec)							

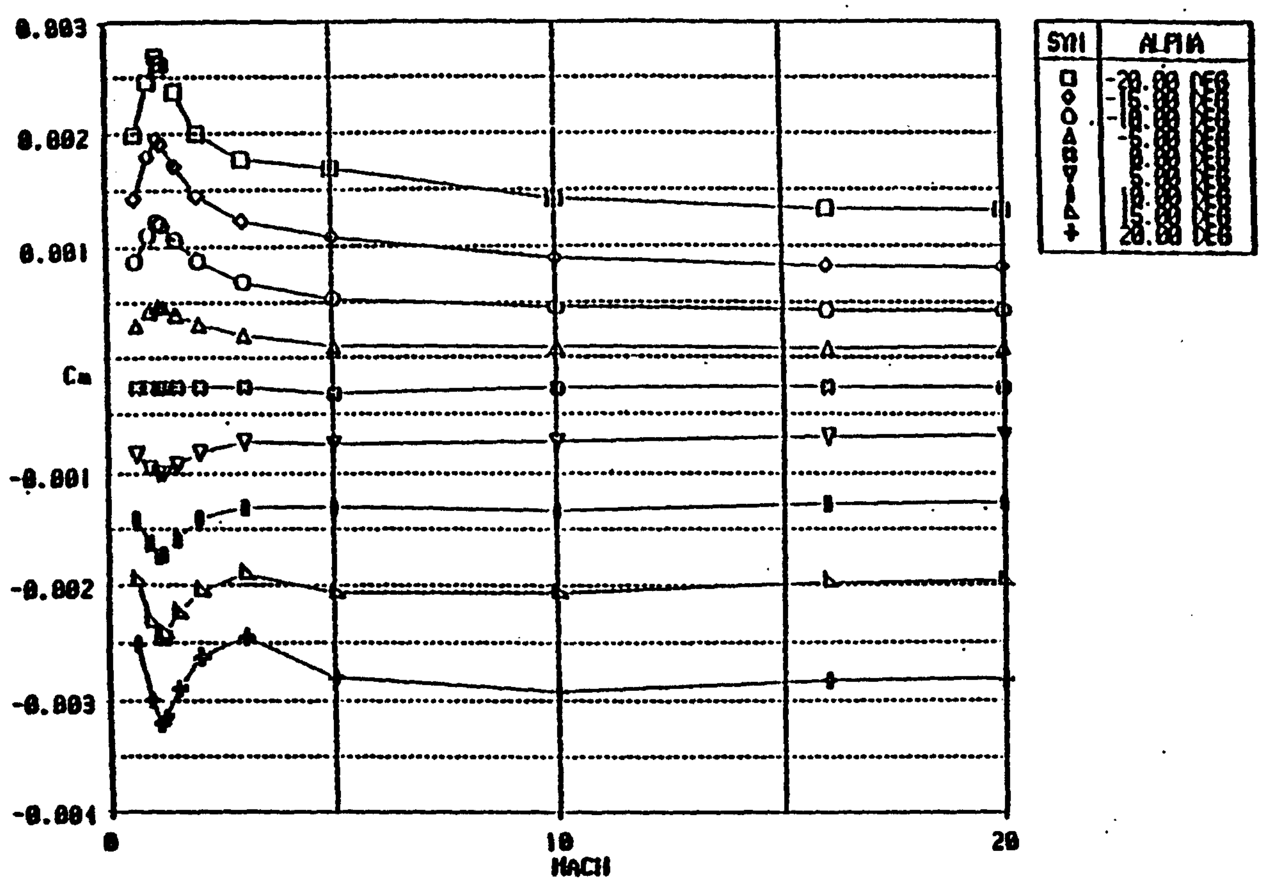
LIFT COEFFICIENT VERSUS MACH NUMBER



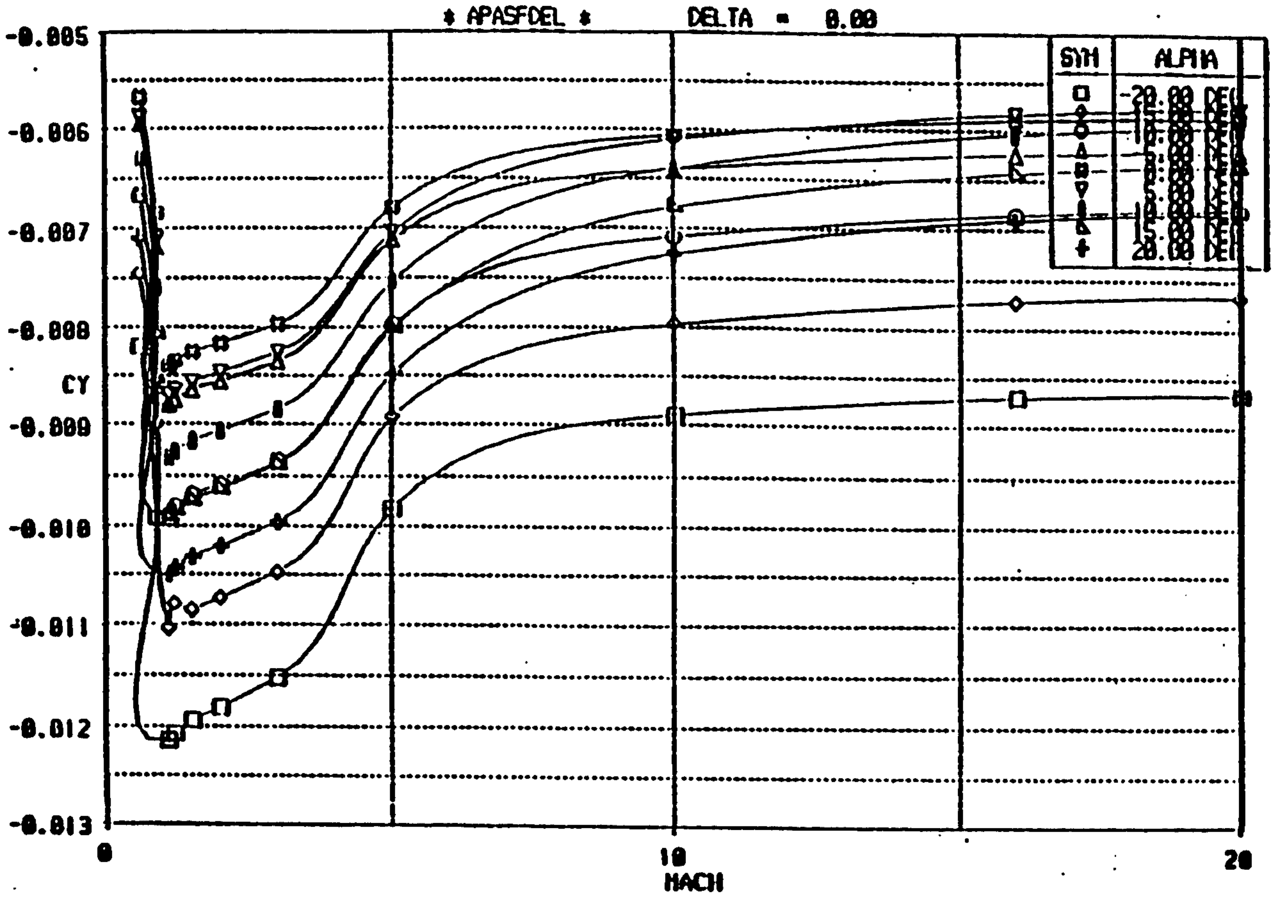
DRAG COEFFICIENT VERSUS MACH NUMBER



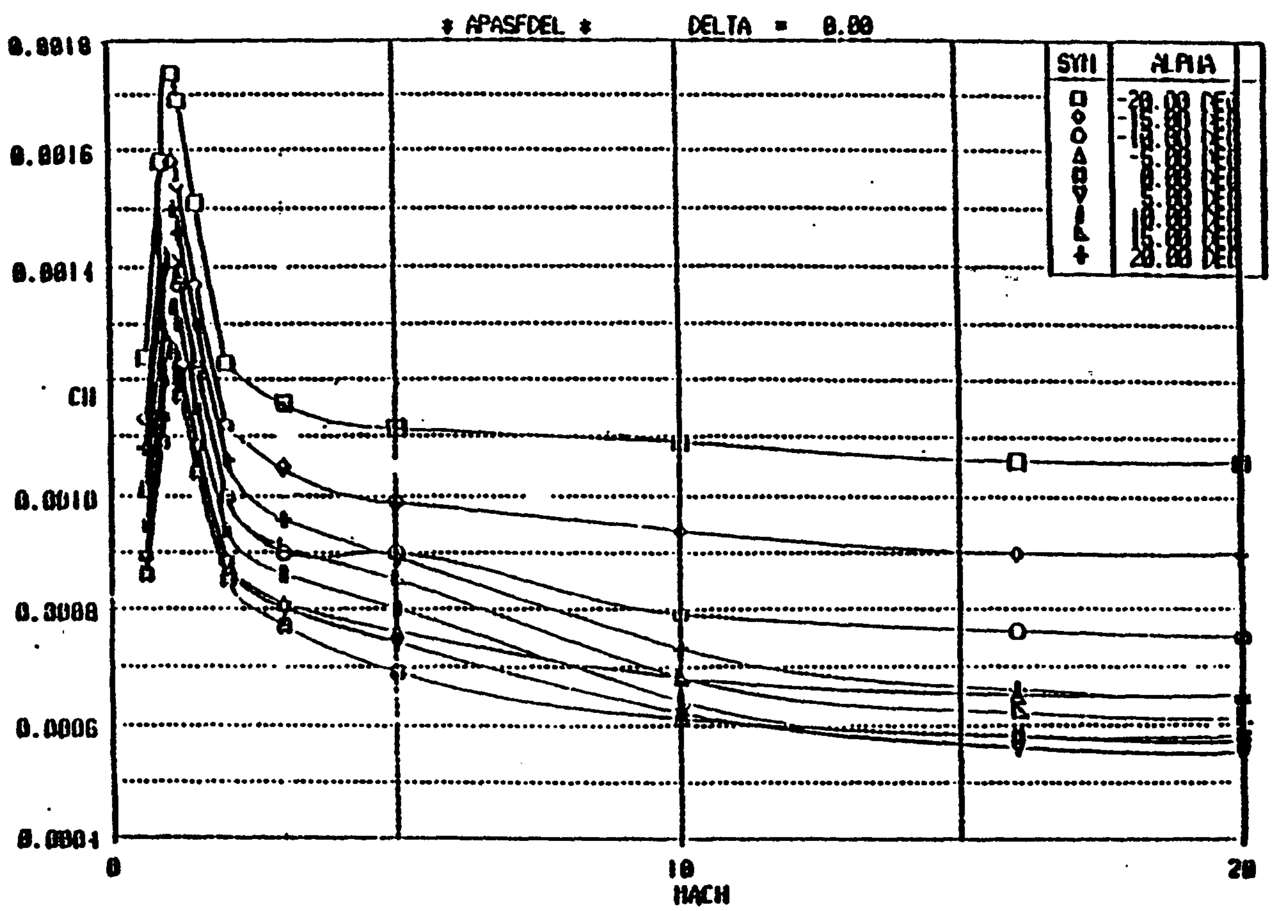
PITCHING MOMENT COEFFICIENT VERSUS MACH NUMBER



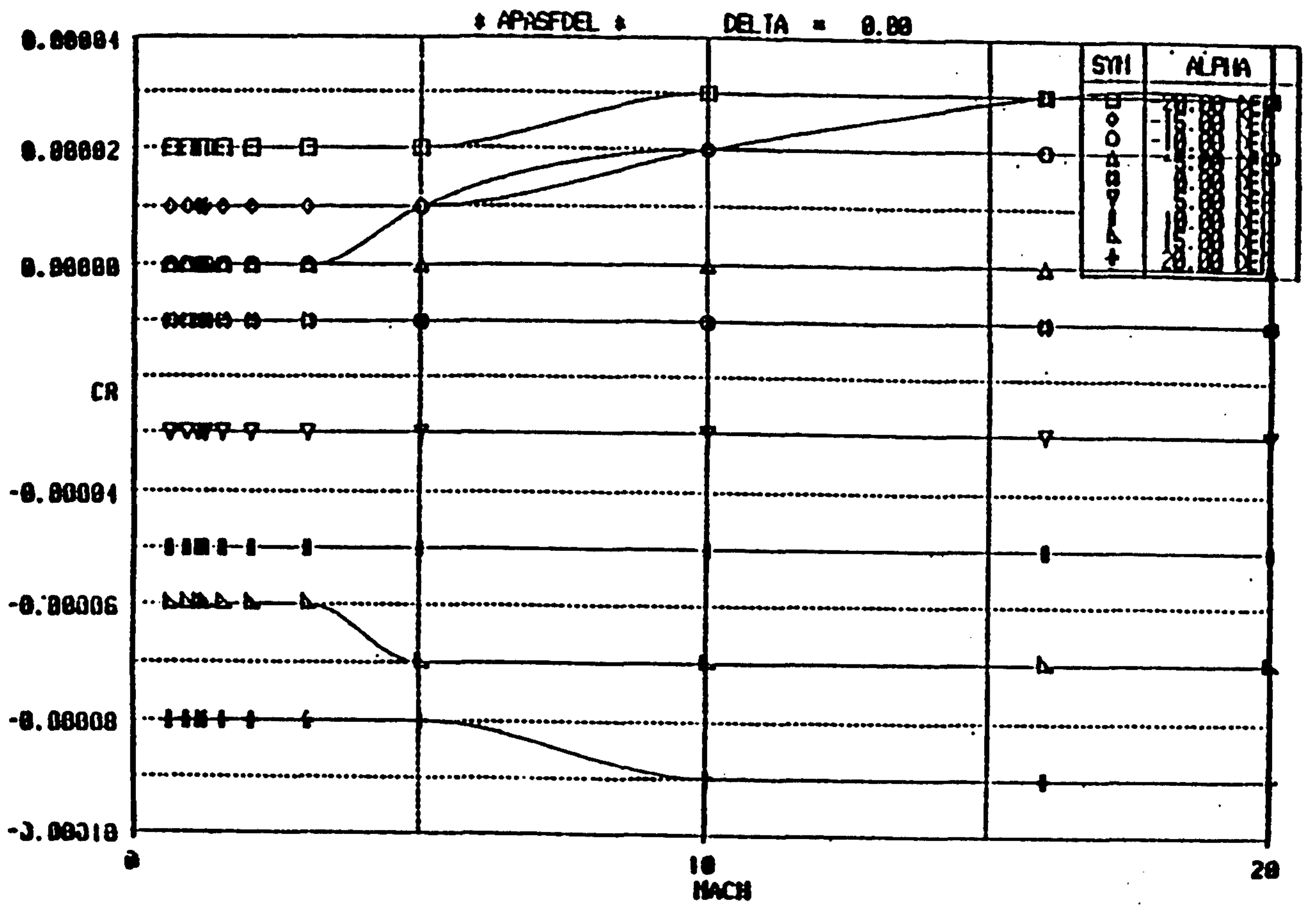
SIDE FORCE COEFFICIENT VERSUS MACH NUMBER, BETA=5

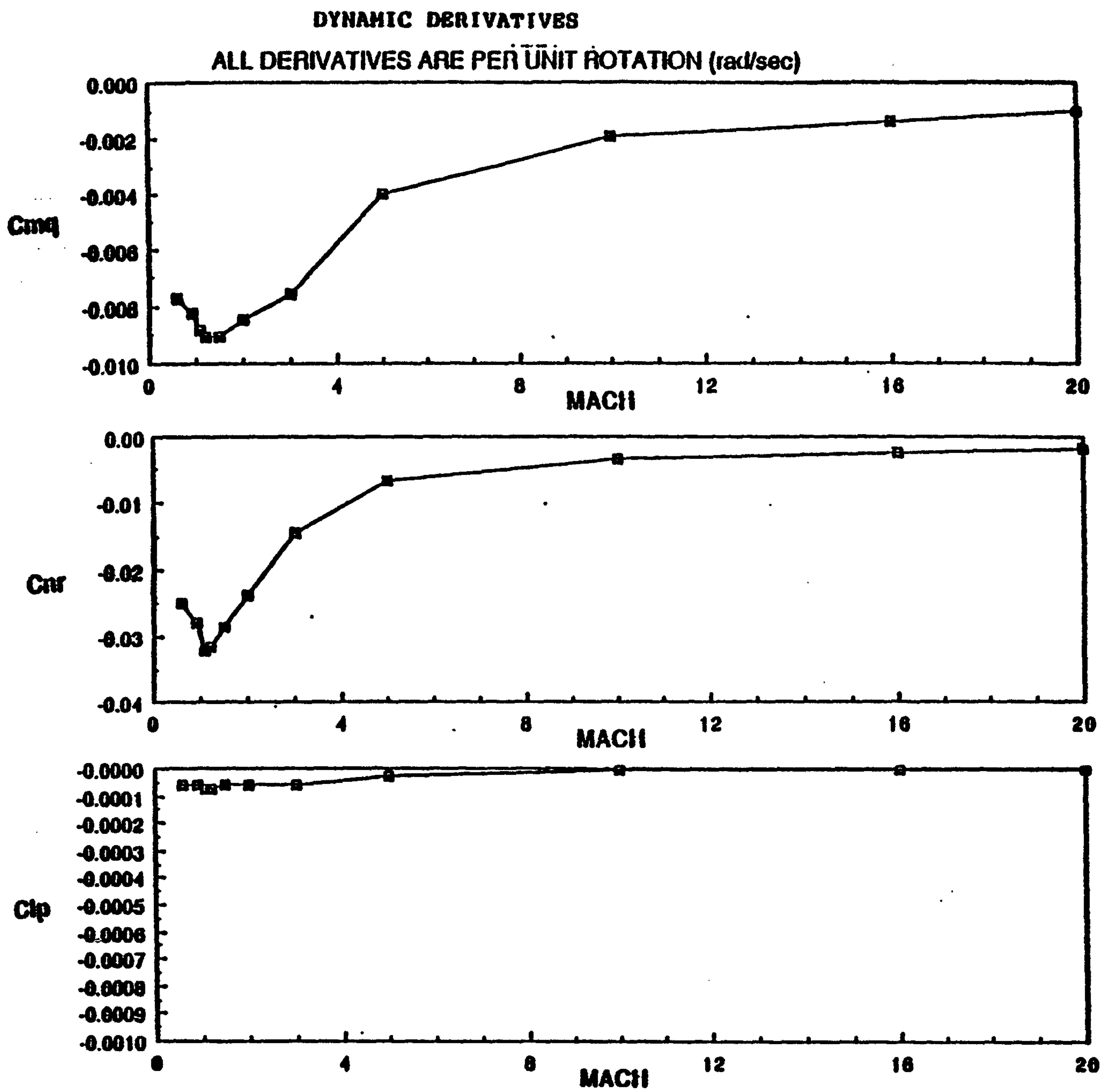


YAWING MOMENT COEFFICIENT VERSUS MACH NUMBER, BETA=5



ROLLING MOMENT COEFFICIENT VERSUS MACH NUMBER, BETA=5




DYNAMIC DERIVATIVES
ALL DERIVATIVES ARE PER UNIT ROTATION (rad/sec)
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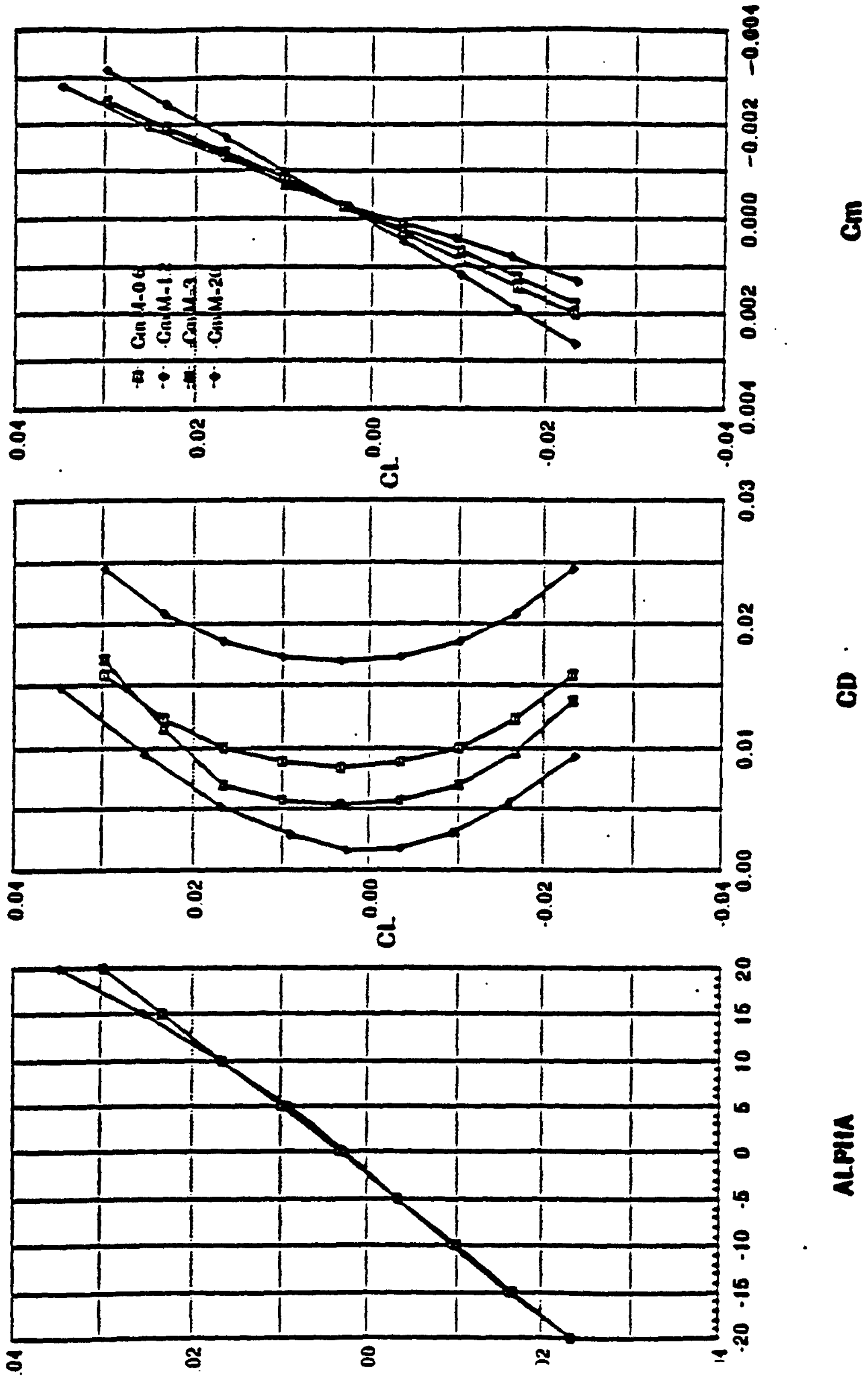
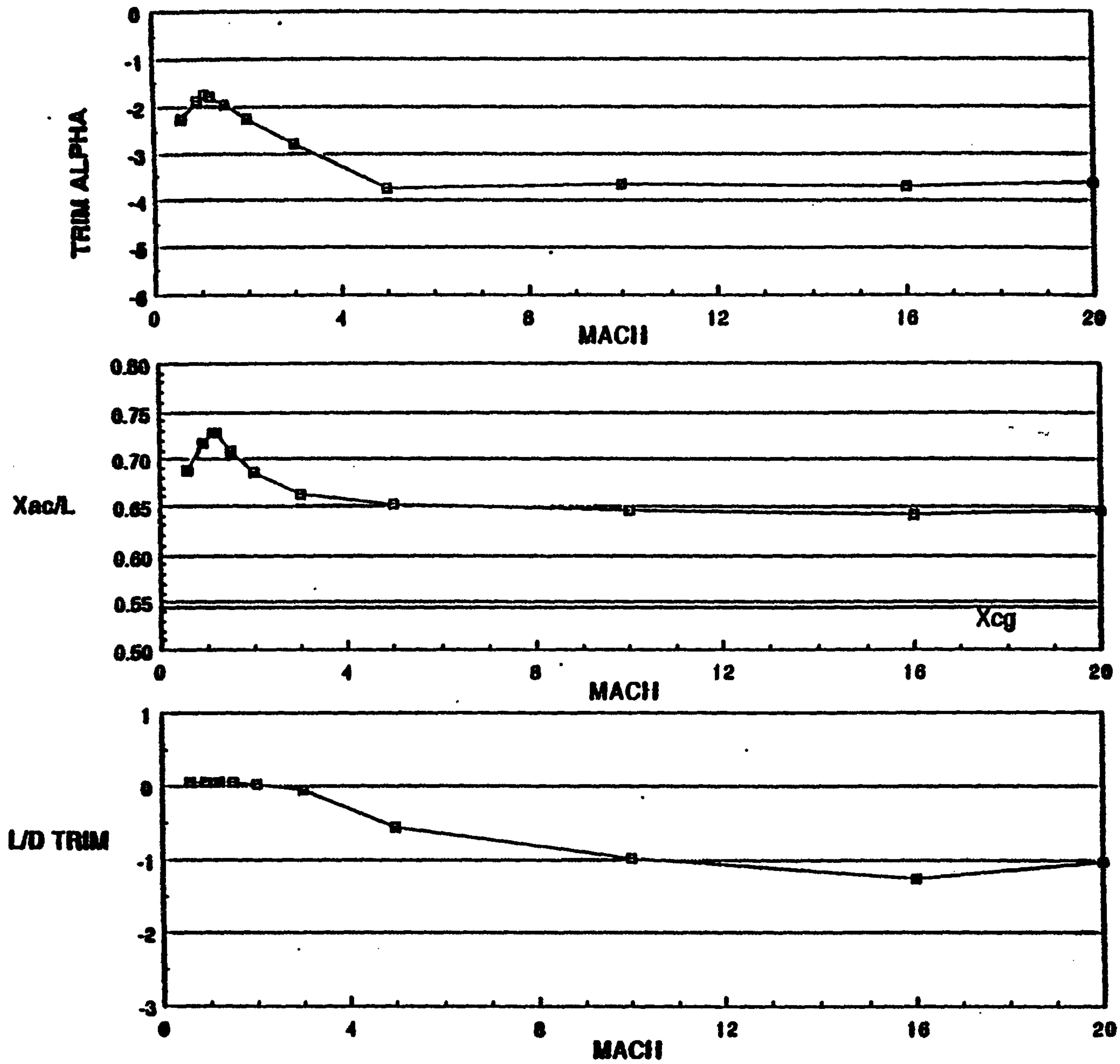
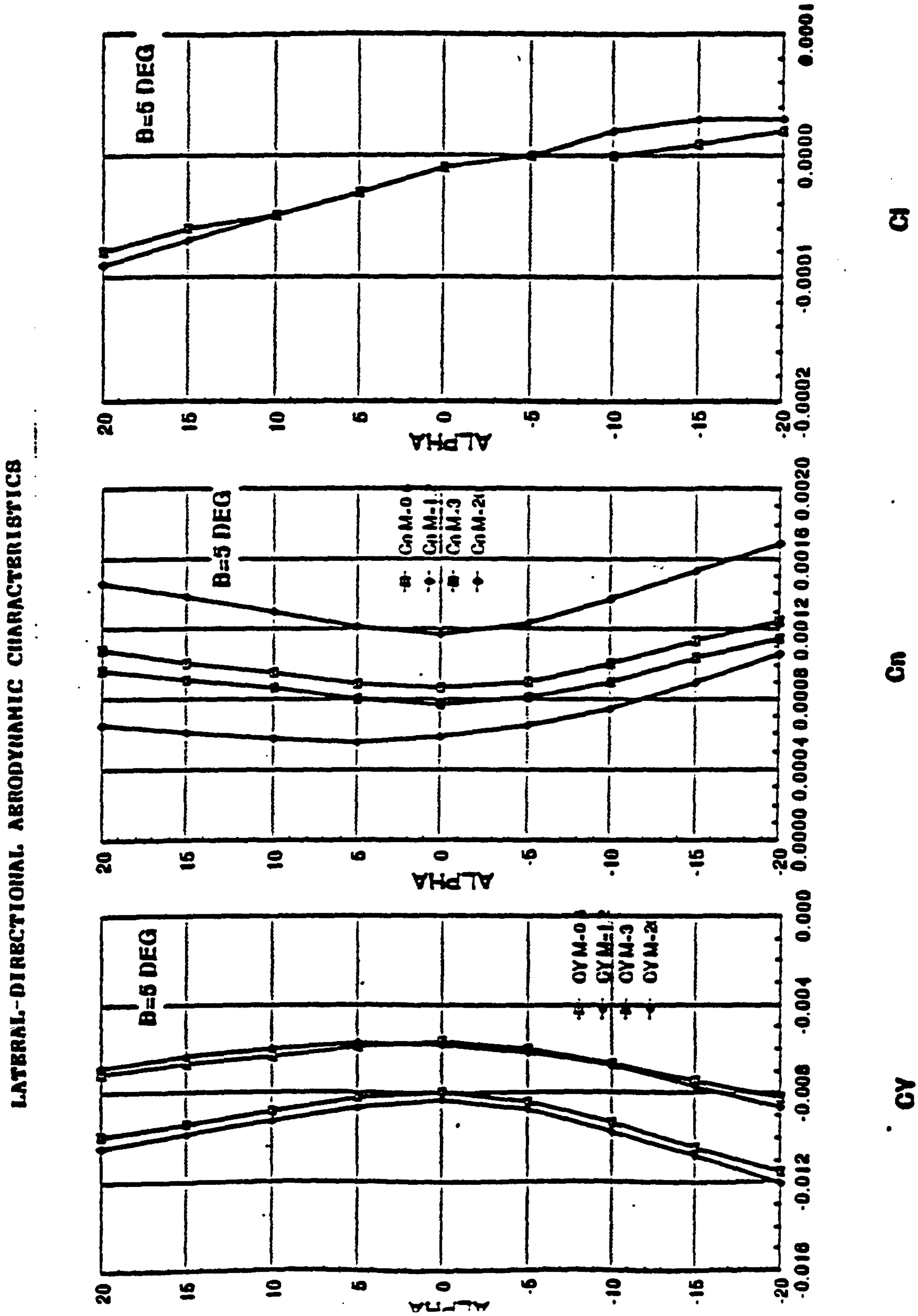
-0.002
-0.004
-0.006
-0.008
-0.010
0
4
8
12
16
20
MACH
Cnr
0.00
-0.01
-0.02
-0.03
-0.04
0
4
8
12
16
20
MACH
Clp
-0.0000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
-0.0009
-0.0010
0
4
8
12
16
20
MACH

LONGITUDINAL AERODYNAMIC CHARACTERISTICS



STATIC STABILITY AND PERFORMANCE CHARACTERISTICS




LATERAL-DIRECTIONAL AERODYNAMIC CHARACTERISTICS
B=5 DEG
ALPHA
Cl
Cn
CY
CnM-0
CnM-1
CnM-3
CYM-0
CYM-1
CYM-3

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.60	32000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.03025	0.01980	0.00239	-1.52778	-0.06546	0.001436
-15.00	0.00	-0.02307	0.01481	0.00192	-1.55773	-0.06685	0.001436
-10.00	0.00	-0.01589	0.01156	0.00144	-1.37457	-0.06695	0.001434
-5.00	0.00	-0.00872	0.00978	0.00096	-0.89162	-0.06685	0.001436
0.00	0.00	-0.00154	0.00924	0.00048	-0.16667	-0.06555	0.001434
5.00	0.00	0.00563	0.00978	0.00001	0.57566	-0.06825	0.001436
10.00	0.00	0.01281	0.01156	-0.00048	1.10813	-0.06546	0.001436
15.00	0.00	0.01999	0.01481	-0.00095	1.34976	-0.06695	0.001434
20.00	0.00	0.02716	0.01980	-0.00143	1.37172	-0.06695	0.001434

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.90	37000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.03025	0.02530	0.00277	-1.19565	-0.07799	0.001436
-15.00	0.00	-0.02307	0.02031	0.00221	-1.13589	-0.08078	0.001436
-10.00	0.00	-0.01589	0.01706	0.00163	-0.93142	-0.07950	0.001434
-5.00	0.00	-0.00872	0.01528	0.00106	-0.57068	-0.08078	0.001436
0.00	0.00	-0.00154	0.01474	0.00048	-0.10448	-0.07950	0.001434
5.00	0.00	0.00563	0.01528	-0.00009	0.36846	-0.08078	0.001436
10.00	0.00	0.01281	0.01706	-0.00067	0.75088	-0.07939	0.001436
15.00	0.00	0.01999	0.02031	-0.00124	0.98424	-0.07950	0.001434
20.00	0.00	0.02716	0.02530	-0.00181	1.07352	-0.07950	0.001434

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.10	39000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.03025	0.03811	0.00295	-0.79375	-0.08357	0.001436
-15.00	0.00	-0.02307	0.03307	0.00235	-0.69761	-0.08774	0.001436
-10.00	0.00	-0.01589	0.02981	0.00172	-0.53304	-0.08508	0.001434
-5.00	0.00	-0.00872	0.02803	0.00111	-0.31110	-0.08774	0.001436
0.00	0.00	-0.00154	0.02749	0.00048	-0.05602	-0.08647	0.001434
5.00	0.00	0.00563	0.02803	-0.00014	0.20086	-0.08635	0.001436
10.00	0.00	0.01281	0.02981	-0.00076	0.42972	-0.08635	0.001436
15.00	0.00	0.01999	0.03307	-0.00138	0.60448	-0.08508	0.001434
20.00	0.00	0.02716	0.03811	-0.00199	0.71267	-0.08508	0.001434

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.20	41500.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.03025	0.03470	0.00291	-0.87176	-0.08357	0.001436
-15.00	0.00	-0.02307	0.02963	0.00231	-0.77860	-0.08496	0.001436
-10.00	0.00	-0.01589	0.02636	0.00170	-0.60281	-0.08368	0.001434
-5.00	0.00	-0.00872	0.02458	0.00110	-0.35476	-0.08635	0.001436
0.00	0.00	-0.00154	0.02404	0.00048	-0.06406	-0.08508	0.001434
5.00	0.00	0.00563	0.02458	-0.00013	0.22905	-0.08496	0.001436
10.00	0.00	0.01281	0.02636	-0.00074	0.48596	-0.08357	0.001436
15.00	0.00	0.01999	0.02963	-0.00134	0.67465	-0.08508	0.001434
20.00	0.00	0.02716	0.03470	-0.00195	0.78271	-0.08508	0.001434

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.50	45500.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.03025	0.02933	0.00268	-1.03137	-0.07521	0.001436
-15.00	0.00	-0.02307	0.02408	0.00214	-0.95806	-0.07660	0.001436

-10.00	0.00	-0.01589	0.02078	0.00159	-0.76468	-0.07671	0.001434
-5.00	0.00	-0.00872	0.01900	0.00104	-0.45895	-0.07799	0.001436
0.00	0.00	-0.00154	0.01846	0.00048	-0.08342	-0.07671	0.001434
5.00	0.00	0.00563	0.01900	-0.00007	0.29632	-0.07799	0.001436
10.00	0.00	0.01281	0.02078	-0.00063	0.61646	-0.07521	0.001436
15.00	0.00	0.01999	0.02408	-0.00117	0.83015	-0.09066	0.001434
20.00	0.00	0.02716	0.02933	-0.00182	0.92601	-0.09066	0.001434

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	2.00	53000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.03025	0.02451	0.00238	-1.23419	-0.06546	0.001436
-15.00	0.00	-0.02307	0.01879	0.00191	-1.22778	-0.06685	0.001436
-10.00	0.00	-0.01589	0.01539	0.00143	-1.03249	-0.06555	0.001434
-5.00	0.00	-0.00872	0.01360	0.00096	-0.64118	-0.06685	0.001436
0.00	0.00	-0.00154	0.01306	0.00048	-0.11792	-0.06555	0.001434
5.00	0.00	0.00563	0.01360	0.00001	0.41397	-0.07521	0.001436
10.00	0.00	0.01281	0.01539	-0.00053	0.83236	-0.06825	0.001436
15.00	0.00	0.01999	0.01950	-0.00102	1.02513	-0.09484	0.001434
20.00	0.00	0.02716	0.02660	-0.00170	1.02105	-0.09484	0.001434

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	3.00	62000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.03025	0.02050	0.00209	-1.47561	-0.05571	0.001436
-15.00	0.00	-0.02307	0.01482	0.00169	-1.55668	-0.05571	0.001436
-10.00	0.00	-0.01589	0.01113	0.00129	-1.42767	-0.05579	0.001434
-5.00	0.00	-0.00872	0.00930	0.00089	-0.93763	-0.05710	0.001436
0.00	0.00	-0.00154	0.00876	0.00048	-0.17580	-0.06974	0.001434
5.00	0.00	0.00563	0.00930	-0.00002	0.60538	-0.06407	0.001436
10.00	0.00	0.01281	0.01113	-0.00048	1.15094	-0.06267	0.001436
15.00	0.00	0.01999	0.01670	-0.00093	1.19701	-0.07950	0.001434
20.00	0.00	0.02716	0.02400	-0.00150	1.13167	-0.07950	0.001434

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	5.00	76000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02683	0.01887	0.00158	-1.42183	-0.04571	0.001400
-15.00	0.00	-0.01983	0.01306	0.00126	-1.51838	-0.04795	0.001460
-10.00	0.00	-0.01253	0.00900	0.00091	-1.39222	-0.06056	0.001354
-5.00	0.00	-0.00576	0.00669	0.00050	-0.86099	-0.06761	0.001272
0.00	0.00	0.00060	0.00609	0.00007	0.09852	-0.06506	0.001414
5.00	0.00	0.00767	0.00727	-0.00039	1.05502	-0.06311	0.001426
10.00	0.00	0.01480	0.01032	-0.00084	1.43411	-0.05857	0.001400
15.00	0.00	0.02180	0.01537	-0.00125	1.41835	-0.05417	0.001440
20.00	0.00	0.02900	0.02239	-0.00164	1.29522	-0.05417	0.001440

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	10.00	106000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02445	0.01710	0.00155	-1.42982	-0.04897	0.001266
-15.00	0.00	-0.01812	0.01156	0.00124	-1.56747	-0.05435	0.001288
-10.00	0.00	-0.01168	0.00766	0.00089	-1.52480	-0.06390	0.001252
5.00	0.00	-0.00542	0.00541	0.00049	-1.00185	-0.06843	0.001286
0.00	0.00	0.00101	0.00482	0.00005	0.20954	-0.06757	0.001332
5.00	0.00	0.00767	0.00597	-0.00040	1.28476	-0.06250	0.001440
10.00	0.00	0.01487	0.00892	-0.00085	1.66704	-0.05683	0.001478
15.00	0.00	0.02226	0.01376	-0.00127	1.61773	-0.05409	0.001442
20.00	0.00	0.02947	0.02050	-0.00166	1.43756	-0.05409	0.001442

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
…IC	16.00	140000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02395	0.01618	0.00153	-1.48022	-0.04815	0.001246
-15.00	0.00	-0.01772	0.01076	0.00123	-1.64684	-0.05618	0.001246
-10.00	0.00	-0.01149	0.00696	0.00088	-1.65086	-0.06547	0.001222
-5.00	0.00	-0.00538	0.00475	0.00048	-1.13263	-0.06740	0.001276
0.00	0.00	0.00100	0.00417	0.00005	0.23981	-0.06839	0.001316
5.00	0.00	0.00758	0.00529	-0.00040	1.43289	-0.06419	0.001402
10.00	0.00	0.01459	0.00816	-0.00085	1.78799	-0.05769	0.001456
15.00	0.00	0.02187	0.01290	-0.00127	1.69535	-0.05285	0.001438
20.00	0.00	0.02906	0.01954	-0.00165	1.48721	-0.05285	0.001438

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	20.00	177000.00	0.	2979.55	29.42	-0.83	0.00
ALPHA	BETA	CL	CD	CM	L/D	St Marg	CLdAlpha
-20.00	0.00	-0.02373	0.01635	0.00153	-1.45138	-0.04685	0.001238
-15.00	0.00	-0.01754	0.01094	0.00124	-1.60329	-0.05854	0.001230
-10.00	0.00	-0.01139	0.00715	0.00088	-1.59301	-0.06623	0.001208
-5.00	0.00	-0.00535	0.00493	0.00048	-1.08519	-0.06782	0.001268
0.00	0.00	0.00099	0.00435	0.00005	0.22759	-0.06891	0.001306
5.00	0.00	0.00752	0.00547	-0.00040	1.37477	-0.06494	0.001386
10.00	0.00	0.01445	0.00835	-0.00085	1.73054	-0.05939	0.001448
15.00	0.00	0.02169	0.01306	-0.00128	1.66080	-0.05307	0.001432
20.00	0.00	0.02885	0.01969	-0.00166	1.46521	-0.05307	0.001432

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.60	32000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00118	-0.00002	-0.00872
-15.00	5.00	-0.00000	0.00000	0.00000	0.00110	-0.00002	-0.00816
-10.00	5.00	-0.00000	0.00000	0.00000	0.00102	-0.00001	-0.00755
-5.00	5.00	-0.00000	0.00000	0.00000	0.00094	-0.00002	-0.00701
0.00	5.00	0.00000	0.00000	0.00000	0.00091	-0.00002	-0.00675
5.00	5.00	0.00000	0.00000	-0.00000	0.00092	-0.00003	-0.00679
10.00	5.00	0.00000	0.00000	-0.00000	0.00094	-0.00004	-0.00701
15.00	5.00	0.00000	0.00000	-0.00000	0.00097	-0.00005	-0.00722
20.00	5.00	0.00000	0.00000	-0.00000	0.00100	-0.00007	-0.00741

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	0.90	37000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00142	-0.00002	-0.01023
-15.00	5.00	-0.00000	0.00000	0.00000	0.00133	-0.00002	-0.00958
-10.00	5.00	-0.00000	0.00000	0.00000	0.00123	-0.00001	-0.00886
-5.00	5.00	-0.00000	0.00000	0.00000	0.00114	-0.00002	-0.00823
0.00	5.00	0.00000	0.00000	0.00000	0.00110	-0.00002	-0.00792
5.00	5.00	0.00000	0.00000	-0.00000	0.00111	-0.00003	-0.00797
10.00	5.00	0.00000	0.00000	-0.00000	0.00114	-0.00004	-0.00823
15.00	5.00	0.00000	0.00000	-0.00000	0.00118	-0.00005	-0.00847
20.00	5.00	0.00000	0.00000	-0.00000	0.00121	-0.00007	-0.00870

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.10	39000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00152	-0.00002	-0.01224
-15.00	5.00	-0.00000	0.00000	0.00000	0.00143	-0.00002	-0.01145
-10.00	5.00	-0.00000	0.00000	0.00000	0.00132	-0.00001	-0.01060
-5.00	5.00	-0.00000	0.00000	0.00000	0.00123	-0.00002	-0.00984
0.00	5.00	0.00000	0.00000	0.00000	0.00118	-0.00002	-0.00947
5.00	5.00	0.00000	0.00000	-0.00000	0.00119	-0.00003	-0.00953
10.00	5.00	0.00000	0.00000	-0.00000	0.00123	-0.00004	-0.00984
15.00	5.00	0.00000	0.00000	-0.00000	0.00126	-0.00005	-0.01012
20.00	5.00	0.00000	0.00000	-0.00000	0.00130	-0.00007	-0.01040

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.20	41500.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00150	-0.00002	-0.01217
-15.00	5.00	-0.00000	0.00000	0.00000	0.00140	-0.00002	-0.01139
-10.00	5.00	-0.00000	0.00000	0.00000	0.00130	-0.00001	-0.01054
-5.00	5.00	-0.00000	0.00000	0.00000	0.00120	-0.00002	-0.00979
0.00	5.00	0.00000	0.00000	0.00000	0.00116	-0.00002	-0.00942
5.00	5.00	0.00000	0.00000	-0.00000	0.00117	-0.00003	-0.00948
10.00	5.00	0.00000	0.00000	-0.00000	0.00120	-0.00004	-0.00979
15.00	5.00	0.00000	0.00000	-0.00000	0.00124	-0.00005	-0.01007
20.00	5.00	0.00000	0.00000	-0.00000	0.00127	-0.00007	-0.01034

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	1.50	45500.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00136	-0.00001	-0.01176
-15.00	5.00	-0.00000	0.00000	0.00000	0.00127	-0.00001	-0.01100

-10.00	5.00	-0.00000	0.00000	0.00000	0.00117	-0.00001	-0.01018
-5.00	5.00	-0.00000	0.00000	0.00000	0.00109	-0.00001	-0.00945
0.00	5.00	0.00000	0.00000	0.00000	0.00105	-0.00002	-0.00910
5.00	5.00	0.00000	0.00000	-0.00000	0.00106	-0.00003	-0.00915
10.00	5.00	0.00000	0.00000	-0.00000	0.00109	-0.00004	-0.00945
15.00	5.00	0.00000	0.00000	-0.00000	0.00112	-0.00005	-0.00973
20.00	5.00	0.00000	0.00000	-0.00000	0.00115	-0.00007	-0.00999

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	2.00	53000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00116	-0.00001	-0.01118
-15.00	5.00	-0.00000	0.00000	0.00000	0.00109	-0.00001	-0.01046
-10.00	5.00	-0.00000	0.00000	0.00000	0.00101	-0.00001	-0.00968
-5.00	5.00	-0.00000	0.00000	0.00000	0.00093	-0.00001	-0.00899
0.00	5.00	0.00000	0.00000	0.00000	0.00090	-0.00002	-0.00865
5.00	5.00	0.00000	0.00000	-0.00000	0.00090	-0.00003	-0.00870
10.00	5.00	0.00000	0.00000	-0.00000	0.00093	-0.00004	-0.00899
15.00	5.00	0.00000	0.00000	-0.00000	0.00096	-0.00005	-0.00925
20.00	5.00	0.00000	0.00000	-0.00000	0.00099	-0.00007	-0.00950

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	3.00	62000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00104	-0.00001	-0.01028
-15.00	5.00	-0.00000	0.00000	0.00000	0.00097	-0.00001	-0.00962
-10.00	5.00	-0.00000	0.00000	0.00000	0.00090	-0.00001	-0.00891
-5.00	5.00	-0.00000	0.00000	0.00000	0.00084	-0.00001	-0.00827
0.00	5.00	0.00000	0.00000	0.00000	0.00080	-0.00002	-0.00796
5.00	5.00	0.00000	0.00000	-0.00000	0.00081	-0.00003	-0.00800
10.00	5.00	0.00000	0.00000	-0.00000	0.00084	-0.00004	-0.00827
15.00	5.00	0.00000	0.00000	-0.00000	0.00086	-0.00005	-0.00851
20.00	5.00	0.00000	0.00000	-0.00000	0.00088	-0.00007	-0.00874

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	5.00	76000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00090	-0.00002	-0.00867
-15.00	5.00	-0.00000	0.00000	0.00000	0.00083	-0.00002	-0.00810
-10.00	5.00	-0.00000	0.00000	0.00000	0.00075	-0.00001	-0.00750
-5.00	5.00	-0.00000	0.00000	0.00000	0.00070	-0.00002	-0.00696
0.00	5.00	0.00000	0.00000	0.00000	0.00067	-0.00002	-0.00670
5.00	5.00	0.00000	0.00000	-0.00000	0.00067	-0.00003	-0.00675
10.00	5.00	0.00000	0.00000	-0.00000	0.00070	-0.00004	-0.00697
15.00	5.00	0.00000	0.00000	-0.00000	0.00073	-0.00005	-0.00717
20.00	5.00	0.00000	0.00000	-0.00000	0.00075	-0.00006	-0.00737

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	10.00	106000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00080	-0.00001	-0.00805
-15.00	5.00	-0.00000	0.00000	0.00000	0.00074	-0.00001	-0.00746
-10.00	5.00	-0.00000	0.00000	0.00000	0.00070	-0.00001	-0.00692
5.00	5.00	-0.00000	0.00000	0.00000	0.00067	-0.00001	-0.00648
0.00	5.00	0.00000	0.00000	0.00000	0.00067	-0.00002	-0.00621
5.00	5.00	0.00000	0.00000	-0.00000	0.00065	-0.00003	-0.00614
10.00	5.00	0.00000	0.00000	-0.00000	0.00066	-0.00004	-0.00623
15.00	5.00	0.00000	0.00000	-0.00000	0.00067	-0.00005	-0.00637
20.00	5.00	0.00000	0.00000	-0.00000	0.00068	-0.00006	-0.00656

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
.IC	16.00	140000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00080	-0.00001	-0.00791
-15.00	5.00	-0.00000	0.00000	0.00000	0.00074	-0.00001	-0.00731
-10.00	5.00	-0.00000	0.00000	0.00000	0.00070	-0.00001	-0.00677
-5.00	5.00	-0.00000	0.00000	0.00000	0.00067	-0.00001	-0.00637
0.00	5.00	0.00000	0.00000	0.00000	0.00066	-0.00002	-0.00610
5.00	5.00	0.00000	0.00000	-0.00000	0.00065	-0.00003	-0.00597
10.00	5.00	0.00000	0.00000	-0.00000	0.00066	-0.00004	-0.00601
15.00	5.00	0.00000	0.00000	-0.00000	0.00067	-0.00005	-0.00614
20.00	5.00	0.00000	0.00000	-0.00000	0.00068	-0.00006	-0.00633

TYPE	MACH	ALTITUDE	DEFLECTION	SREF	XCG	ZCG	YCG
BASIC	20.00	177000.00	0.	2979.55	29.42	0.00	-0.83
ALPHA	BETA	CL	CD	CM	C YAW	C ROLL	C SIDE
-20.00	5.00	-0.00000	0.00000	0.00000	0.00080	-0.00001	-0.00788
-15.00	5.00	-0.00000	0.00000	0.00000	0.00074	-0.00001	-0.00727
-10.00	5.00	-0.00000	0.00000	0.00000	0.00070	-0.00001	-0.00674
-5.00	5.00	-0.00000	0.00000	0.00000	0.00067	-0.00001	-0.00635
0.00	5.00	0.00000	0.00000	0.00000	0.00067	-0.00002	-0.00608
5.00	5.00	0.00000	0.00000	-0.00000	0.00065	-0.00003	-0.00593
10.00	5.00	0.00000	0.00000	-0.00000	0.00066	-0.00004	-0.00596
15.00	5.00	0.00000	0.00000	-0.00000	0.00067	-0.00005	-0.00610
20.00	5.00	0.00000	0.00000	-0.00000	0.00068	-0.00006	-0.00629

DATA SHEET DYNAMIC DERIVATIVES

$L_B = 555$ IN.

M	C_{Y_p}	C_{l_p}	C_{n_p}	C_{L_q}	C_{m_q}	C_{Y_r}	C_{l_r}	C_{n_r}
0.6	.00131	-.00005	-.00036	.03065	-.00526	.05613	-.00033	-.01892
0.9	.00145	-.00005	-.00040	.03223	-.00561	.06267	-.00037	-.02124
1.1	.00163	-.00006	-.00046	.03393	-.00604	.07116	-.00041	-.02444
1.2	.00150	-.00006	-.00042	.03419	-.00619	.07003	-.00041	-.02410
1.5	.00117	-.00005	-.00033	.03238	-.00617	.06304	-.00040	-.02174
2	.00098	-.00005	-.00028	.02823	-.00581	.05168	-.00035	-.01794
3	.00069	-.00004	-.00020	.02117	-.00521	.03194	-.00023	-.01112
5	.00036	-.00003	-.00015	.01456	-.00270	.01453	-.00015	-.00501
10	.00018	-.00002	-.00008	.00729	-.00133	.00723	-.00008	-.00246
16	.00013	-.00001	-.00006	.00526	-.00095	.00520	-.00005	-.00175
20	.00010	-.00001	-.00004	.00391	-.00064	.00375	-.00004	-.00128

All derivatives are per unit rotation (rad/sec)

APPENDIX F

Trajectory Analysis
Output Plots for Cases 1 - 13

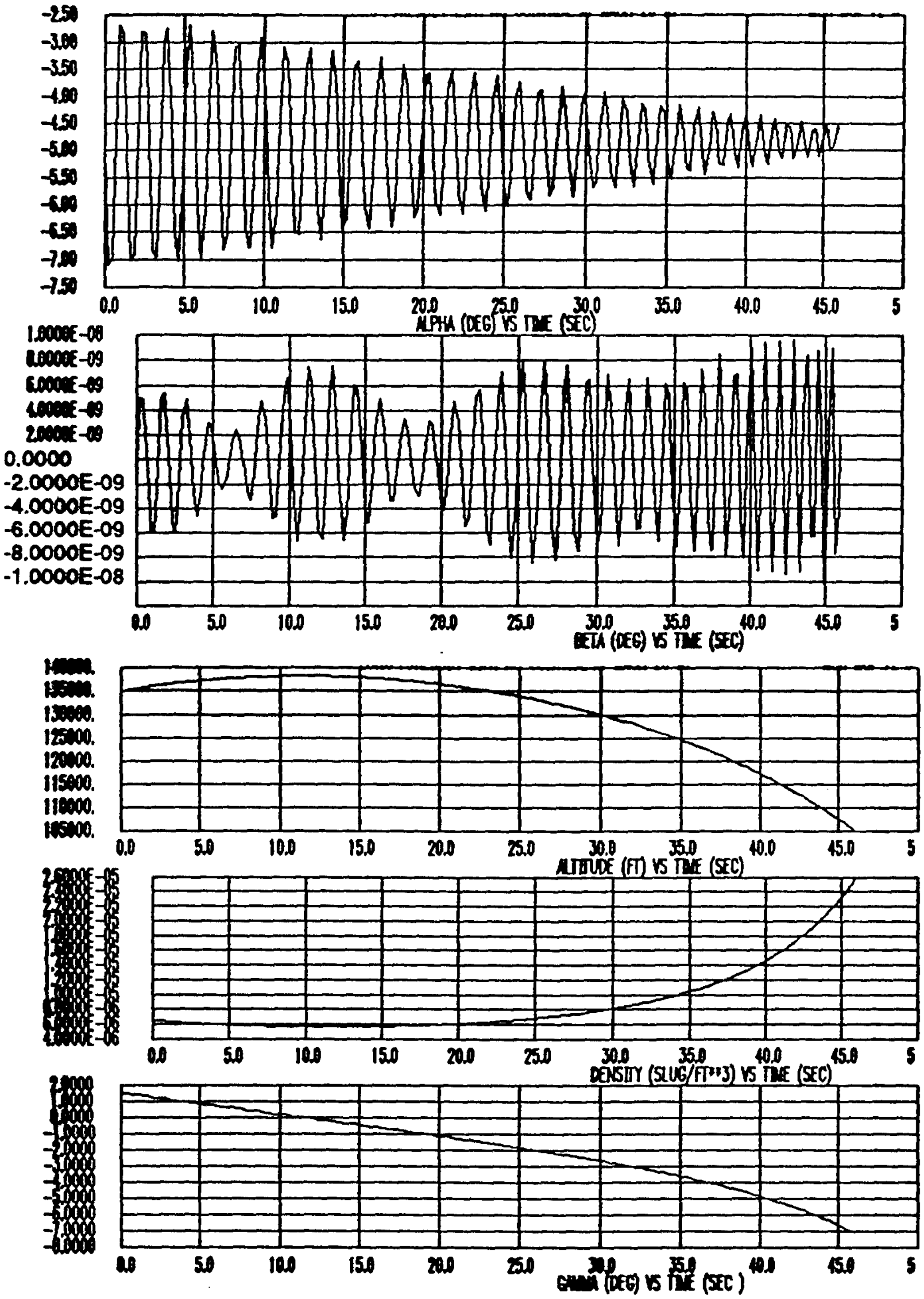
This appendix contains the plotted output for the trajectory analysis performed under Task IV. The plots are presented case-by-case according to the matrix below. Further description of the cases and associated results are found in Task IV of this report.

CETAP Cases 1 - 12 run for configuration refinement 1 and the aerosurface system.

	Cases											
Initial Mach #	1	2	3	4	5	6	7	8	9	10	11	12
Mach 20.0	No Initial Conditions (IC's) No control	No IC's Purely Inverted Flight	Bank Angle Command (BAC), IC's Inverted	BAC, IC's Mach 5.0 Drogue Deploy. Inverted	BAC, IC's Mach 20.0 Ballute Deploy. Upright				BAC, IC's IDS Deploy. Upright			
Mach 6.0						BAC, IC's Mach 3.0 Drogue Deploy. Inverted				BAC, IC's IDS Deploy. Upright		
Mach 3.0							BAC, IC's Mach 3.0 Drogue Deploy. Upright				BAC, IC's IDS Deploy. Upright	
Mach 1.5								BAC, IC's Mach 1.5 Drogue Deploy. Upright				BAC, IC's IDS Deploy. Upright

CETAP Case 13 was run for configuration refinement 2 (with an increased span) at Mach 20.0 failure initial conditions.

Case 1


ALPHA (DEG) VS TIME (SEC)
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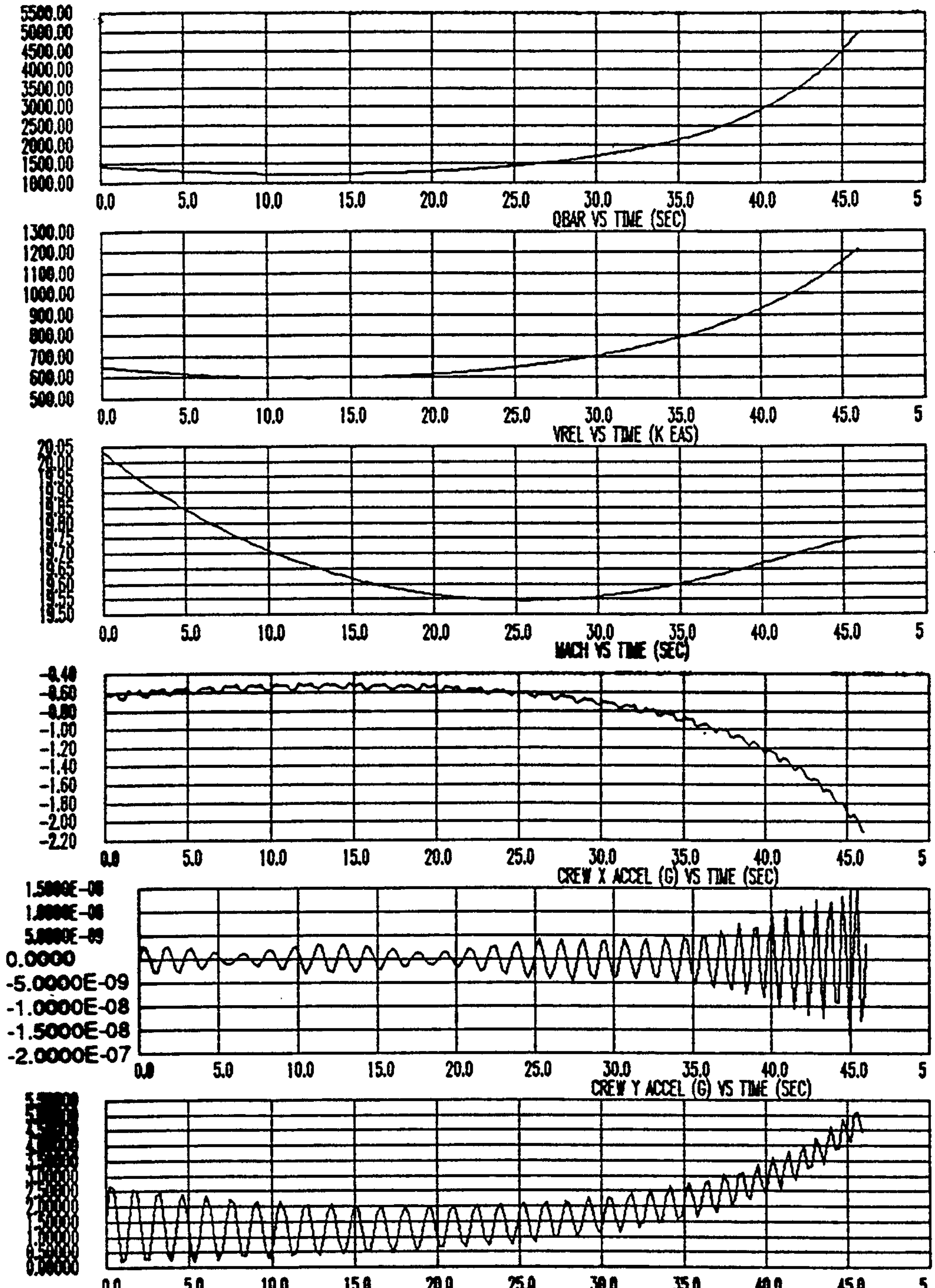
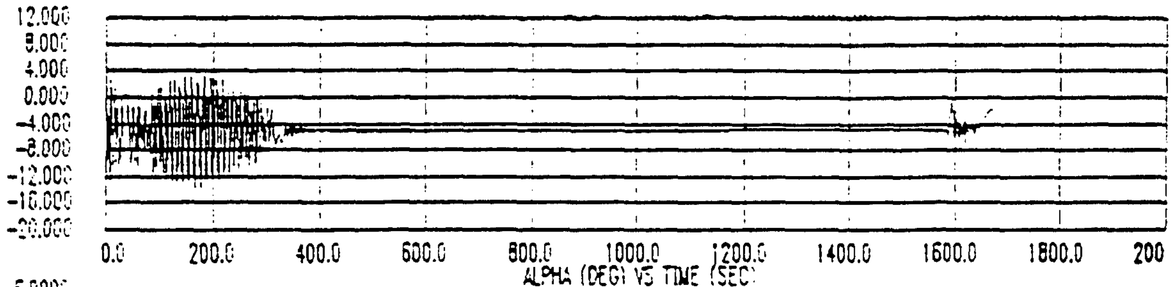
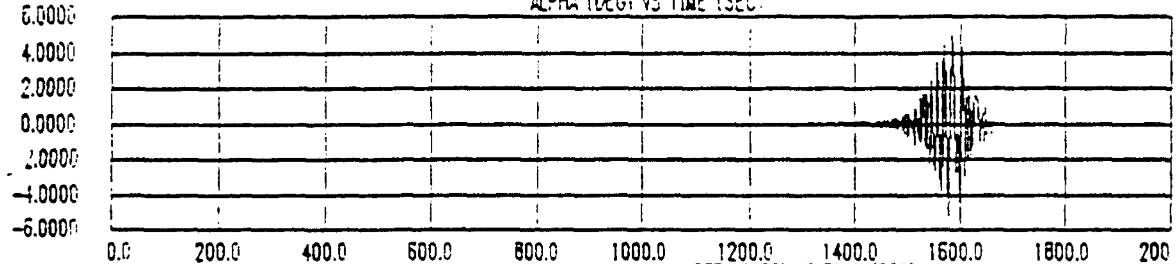
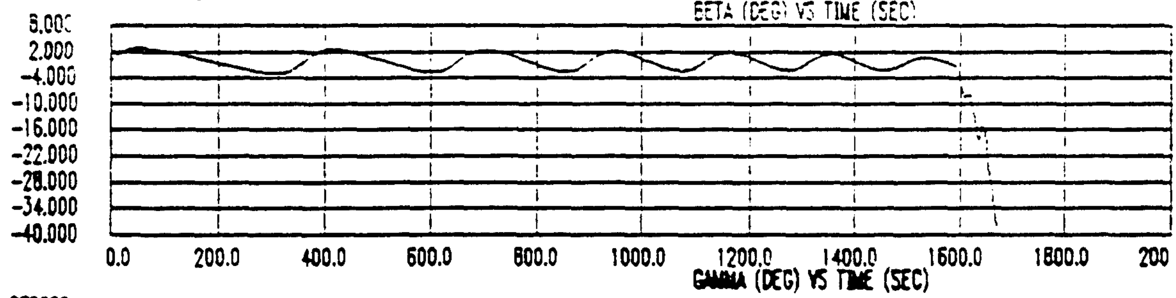
-2.0000E-09
-4.0000E-09
-6.0000E-09
-8.0000E-09
-1.0000E-08
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)

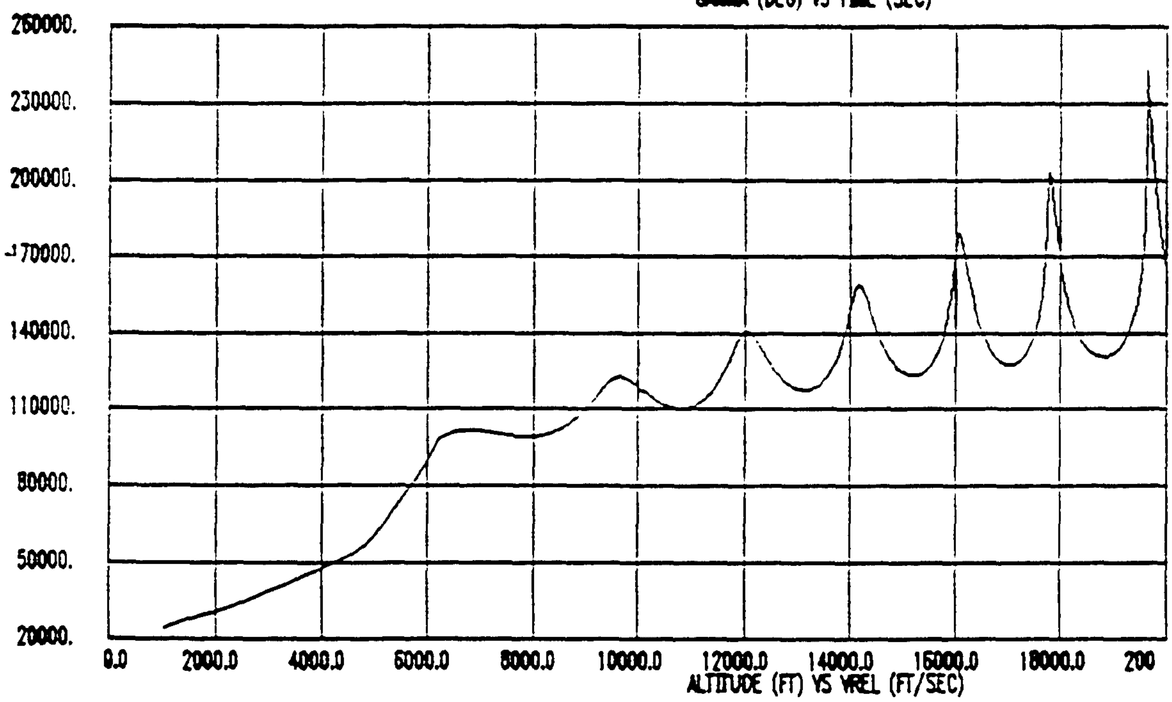
Case 1


5500.00
5000.00
4500.00
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 5
QBAR VS TIME (SEC)
1300.00
1200.00
1100.00
1000.00
900.00
800.00
700.00
600.00
500.00
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 5
VREL VS TIME (K EAS)
20.05
19.50
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 5
MACH VS TIME (SEC)
-1.00
-1.20
-1.40
-1.60
-1.80
-2.00
-2.20
5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 5
CREW X ACCEL (G) VS TIME (SEC)
0.0000
-5.0000E-09
-1.0000E-08
-1.5000E-08
-2.0000E-07
5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 5
CREW Y ACCEL (G) VS TIME (SEC)
0.0 5.0 10.0 15.0 20.0 25.0 45.0 5
CREW Z ACCEL (G) VS TIME (SEC)

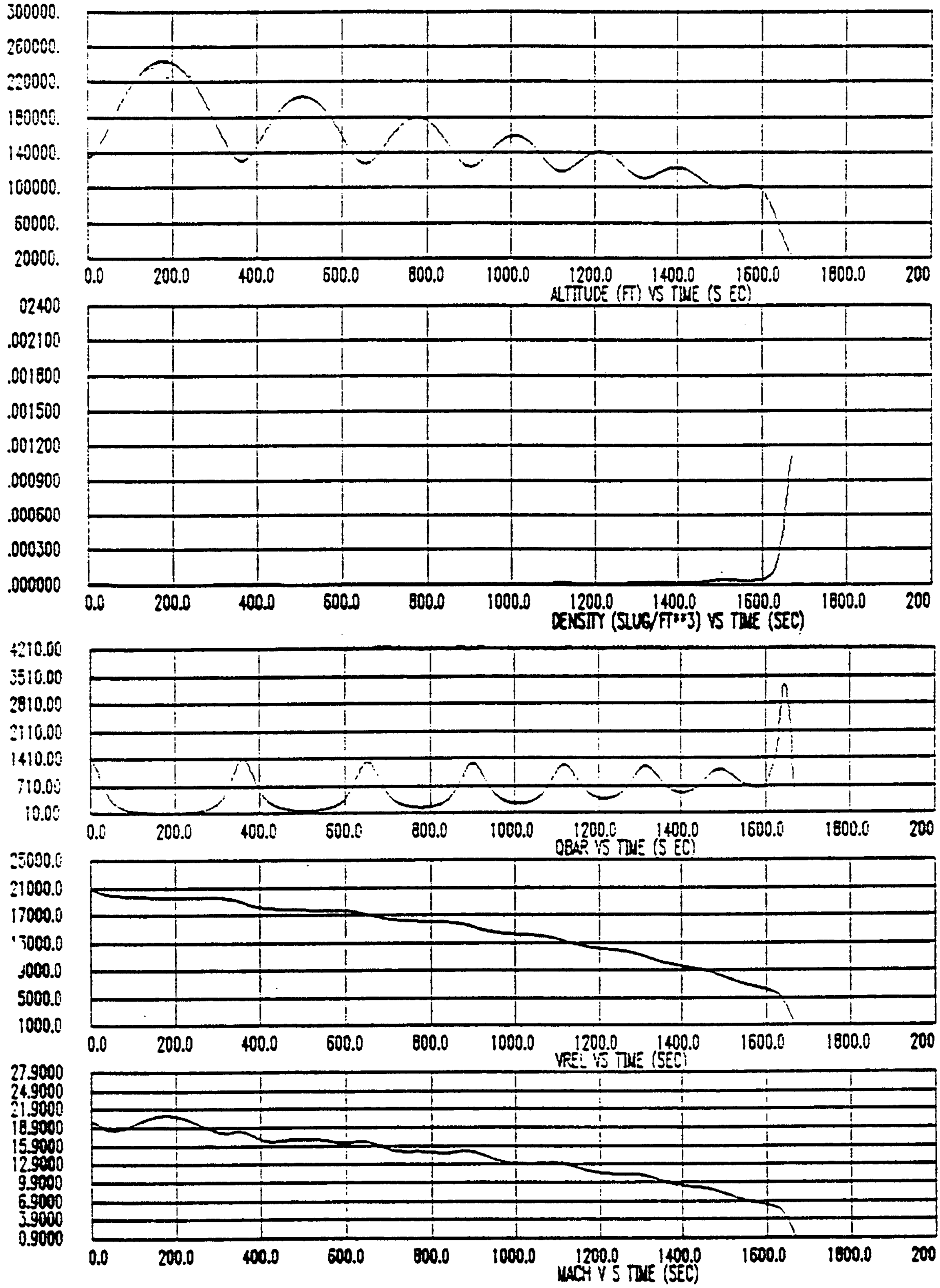

12.000
8.000
4.000
0.000
-4.000
-8.000
-12.000
-16.000
-20.000
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1400.0
1600.0
1800.0
200
ALPHA (DEG) VS TIME (SEC)


6.0000
4.0000
2.0000
0.0000
-2.0000
-4.0000
-6.0000
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1400.0
1600.0
1800.0
200
BETA (DEG) VS TIME (SEC)

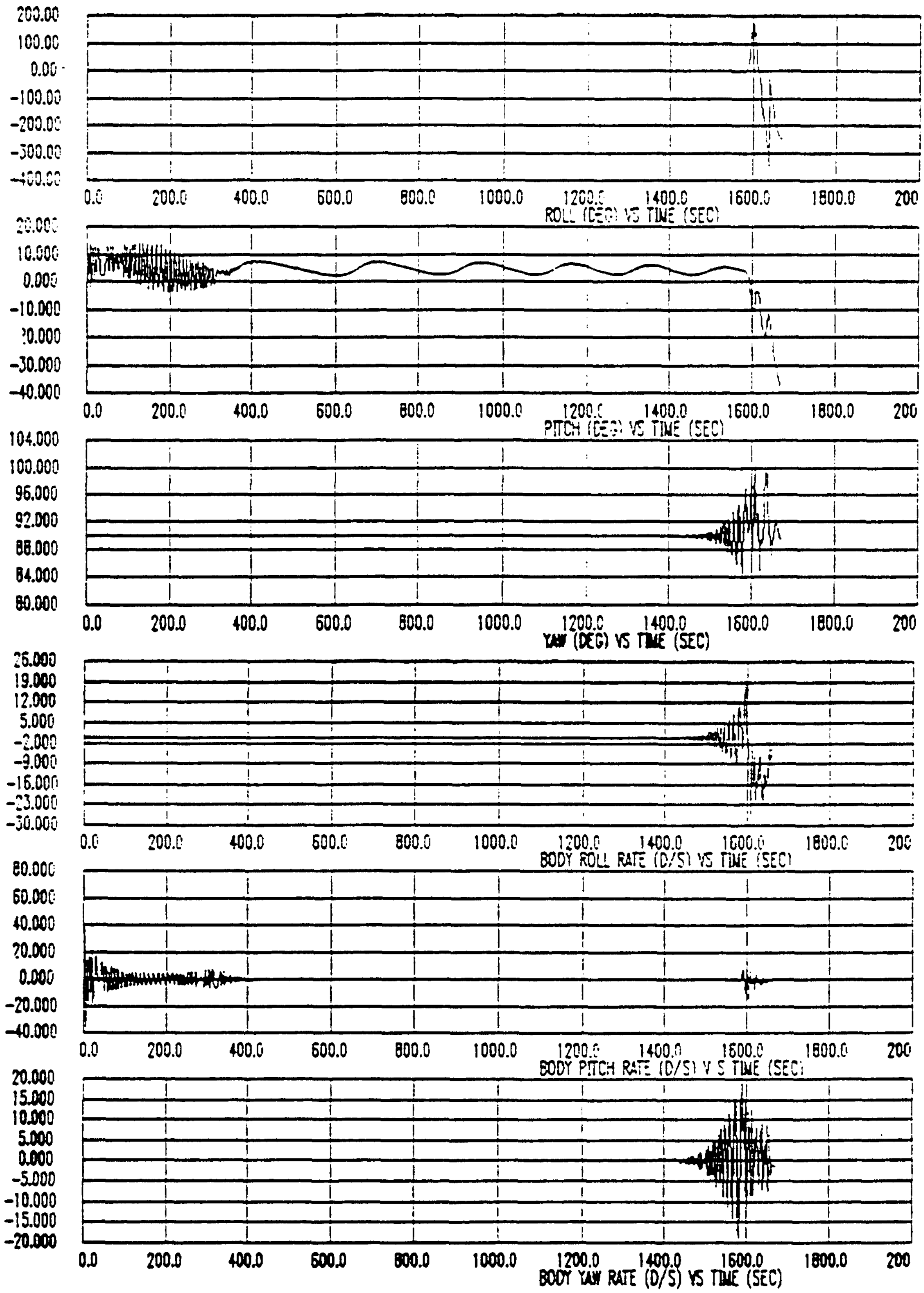

8.000
2.000
-4.000
-10.000
-16.000
-22.000
-28.000
-34.000
-40.000
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1400.0
1600.0
1800.0
200
GAMMA (DEG) VS TIME (SEC)


260000.
230000.
200000.
170000.
140000.
110000.
80000.
50000.
20000.
0.0
2000.0
4000.0
6000.0
8000.0
10000.0
12000.0
14000.0
16000.0
18000.0
200
ALTITUDE (FT) VS VREL (FT/SEC)

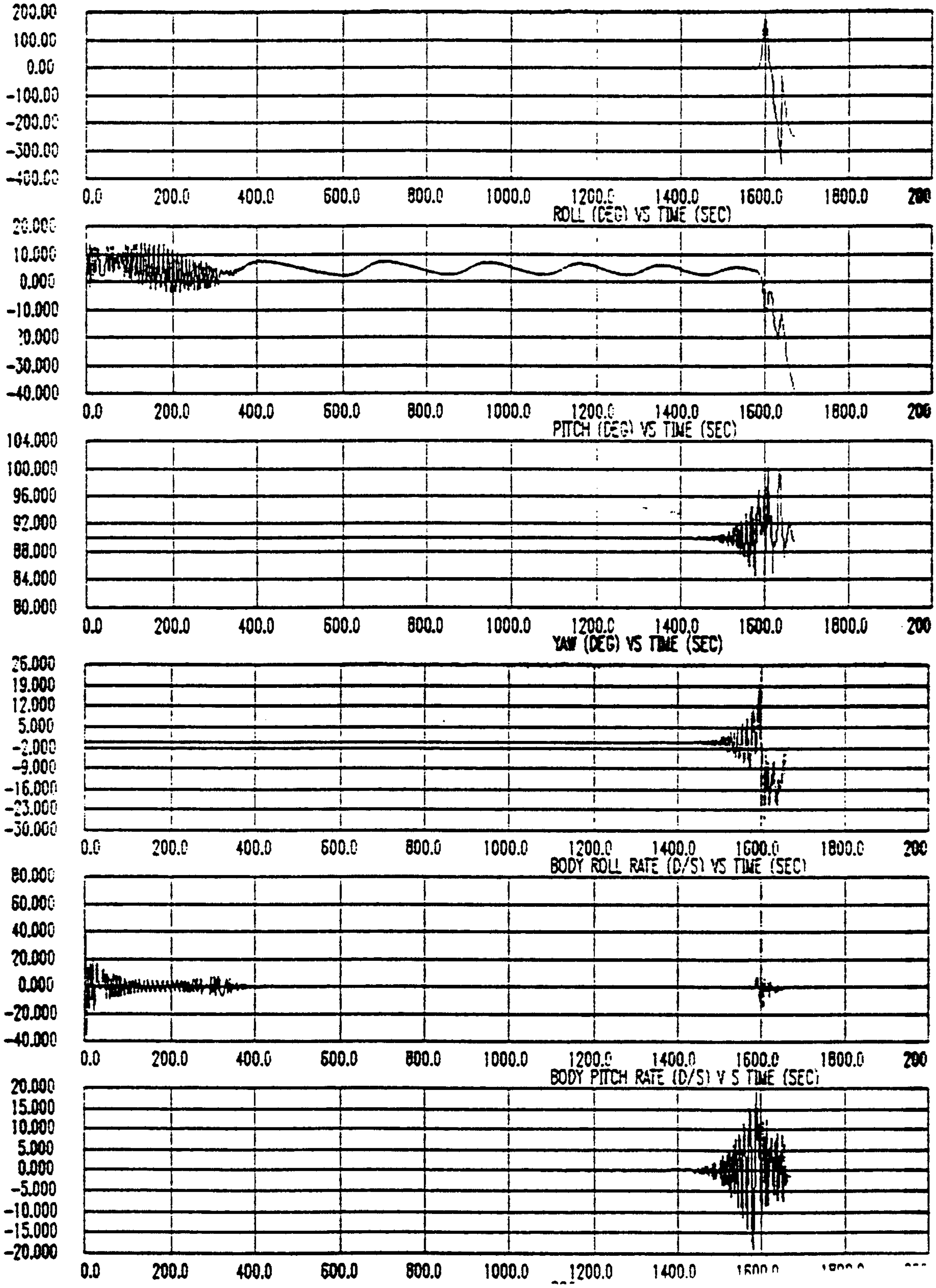
Case 2


300000.
260000.
220000.
180000.
140000.
100000.
60000.
20000.
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
ALTITUDE (FT) VS TIME (S EC)
.002400
.002100
.001800
.001500
.001200
.000900
.000600
.000300
.000000
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
DENSITY (SLUG/FT**3) VS TIME (SEC)
4210.00
3510.00
2810.00
2110.00
1410.00
710.00
10.00
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
QBAR VS TIME (S EC)
25000.0
21000.0
17000.0
13000.0
9000.0
5000.0
1000.0
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
VREL VS TIME (SEC)
27.9000
24.9000
21.9000
18.9000
15.9000
12.9000
9.9000
6.9000
3.9000
0.9000
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
MACH V S TIME (SEC)

Case 2

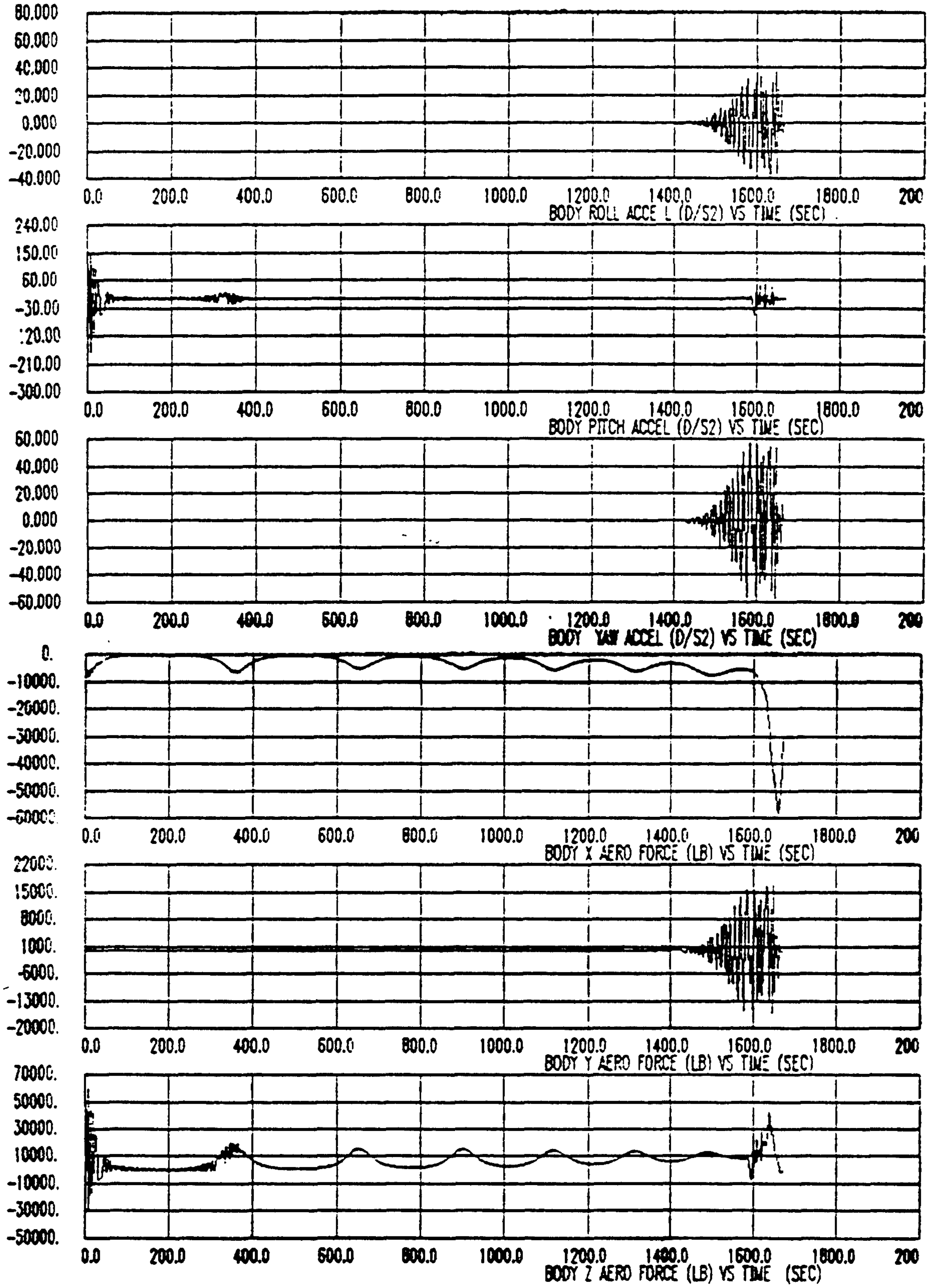

200.00
100.00
0.00
-100.00
-200.00
-300.00
-400.00
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1400.0
1600.0
1800.0
200
ROLL (DEG) VS TIME (SEC)
20.000
10.000
0.000
-10.000
-20.000
-30.000
-40.000
PITCH (DEG) VS TIME (SEC)
104.000
100.000
96.000
92.000
88.000
84.000
80.000
YAW (DEG) VS TIME (SEC)
26.000
19.000
12.000
5.000
-2.000
-9.000
-16.000
-23.000
-30.000
BODY ROLL RATE (D/S) VS TIME (SEC)
80.000
60.000
40.000
20.000
0.000
-20.000
-40.000
BODY PITCH RATE (D/S) V S TIME (SEC)
20.000
15.000
10.000
5.000
0.000
-5.000
-10.000
-15.000
-20.000
BODY YAW RATE (D/S) VS TIME (SEC)

Case 2

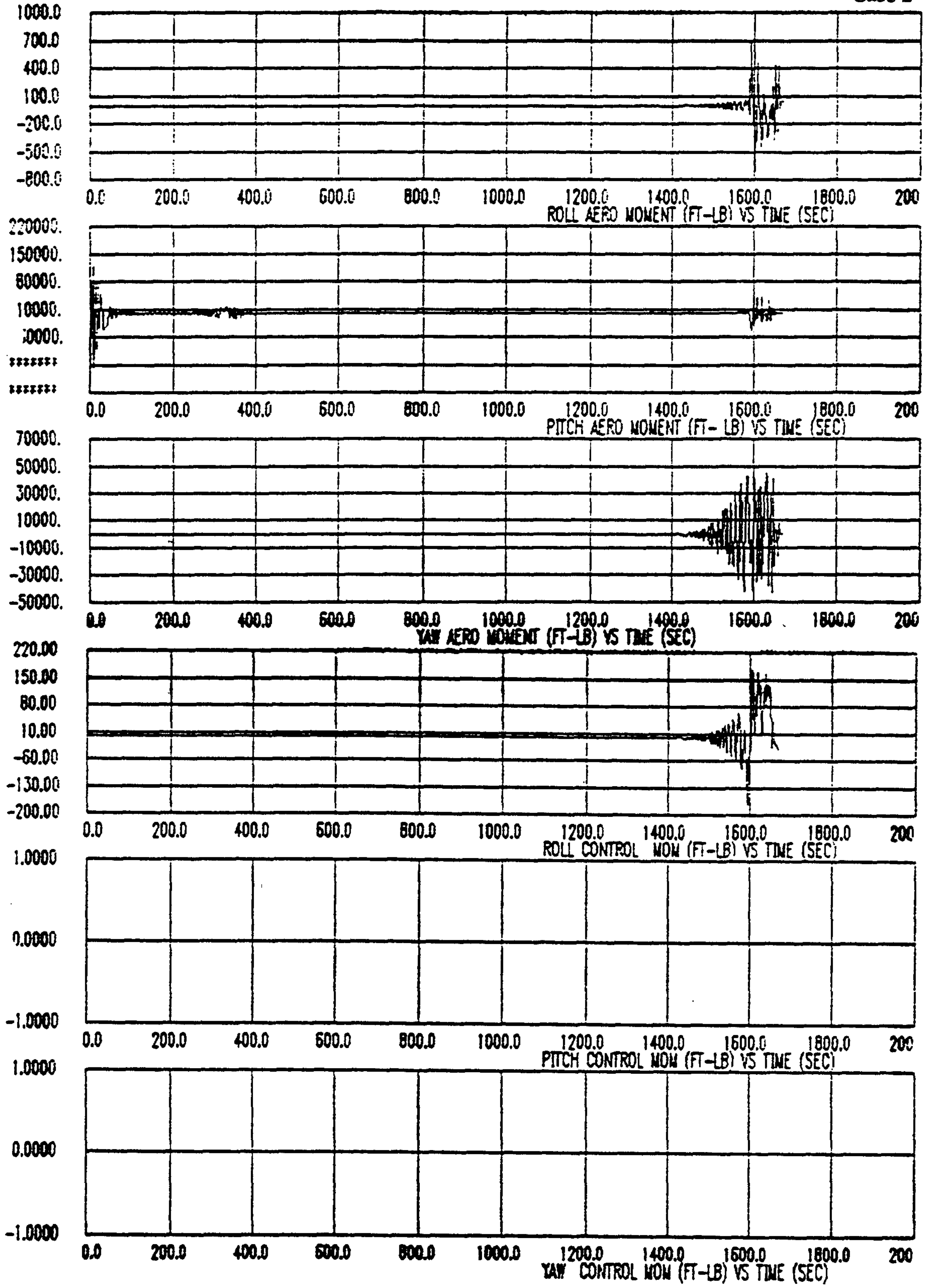


200.00
100.00
0.00
-100.00
-200.00
-300.00
-400.00
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0
ROLL (DEG) VS TIME (SEC)
10.000
0.000
-10.000
-30.000
-40.000
PITCH (DEG) VS TIME (SEC)
104.000
100.000
96.000
92.000
88.000
84.000
80.000
YAW (DEG) VS TIME (SEC)
19.000
12.000
5.000
-9.000
-16.000
-30.000
BODY ROLL RATE (D/S) VS TIME (SEC)
80.000
60.000
40.000
20.000
0.000
-20.000
-40.000
BODY PITCH RATE (D/S) V S TIME (SEC)
20.000
15.000
10.000
5.000
0.000
-5.000
-10.000
-15.000
-20.000

Case 2

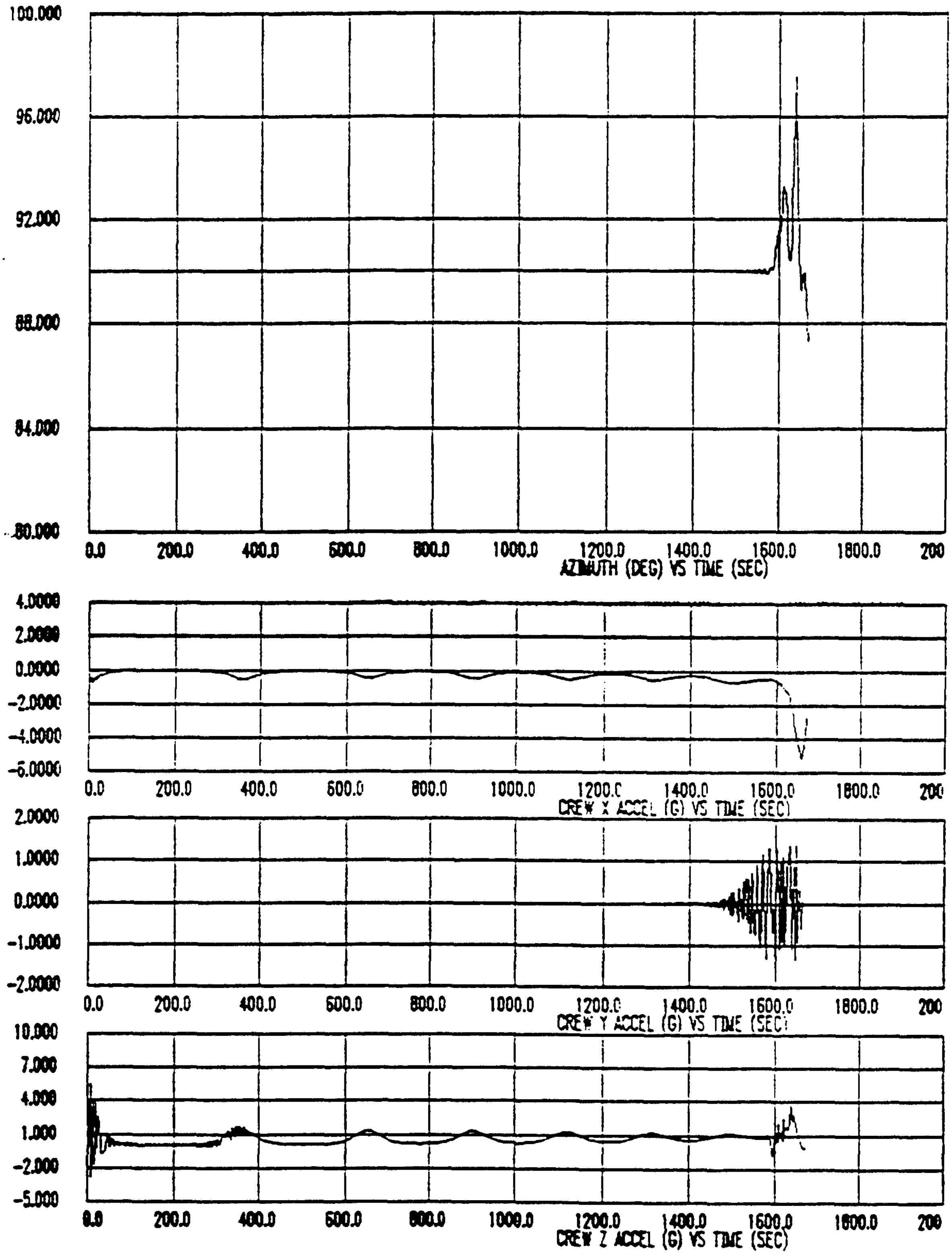

80.000
60.000
40.000
20.000
0.000
-20.000
-40.000
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1400.0
1600.0
1800.0
BODY ROLL ACCEL (D/S2) VS TIME (SEC)
240.00
150.00
60.00
-30.00
-210.00
-300.00
BODY PITCH ACCEL (D/S2) VS TIME (SEC)
60.000
40.000
20.000
0.000
-20.000
-40.000
-60.000
BODY YAW ACCEL (D/S2) VS TIME (SEC)
0.
-10000.
-20000.
-30000.
-40000.
-50000.
BODY X AERO FORCE (LB) VS TIME (SEC)
15000.
8000.
1000.
-6000.
-13000.
-20000.
BODY Y AERO FORCE (LB) VS TIME (SEC)
70000.
50000.
30000.
10000.
-10000.
-30000.
-50000.
BODY Z AERO FORCE (LB) VS TIME (SEC)

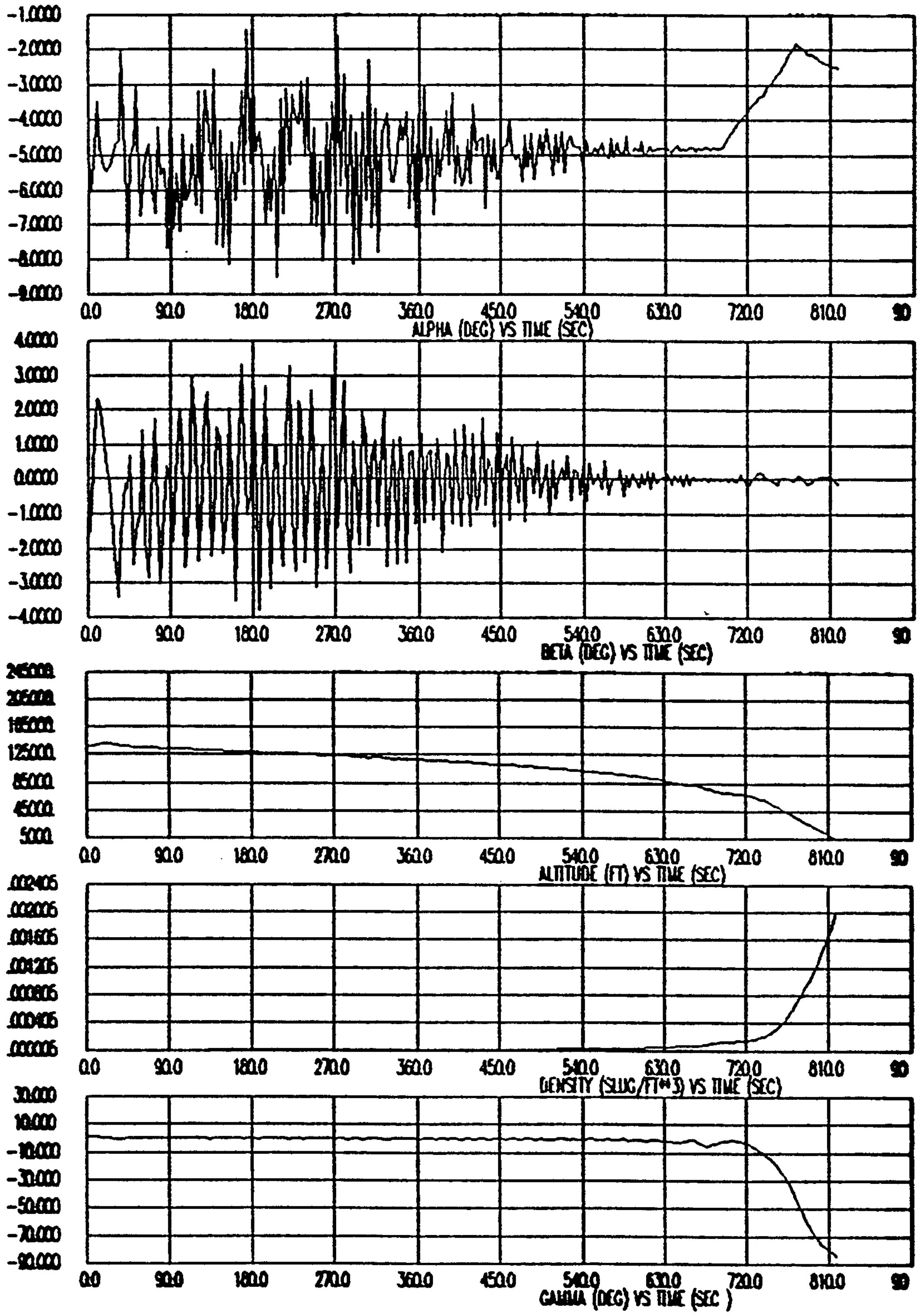
Case 2

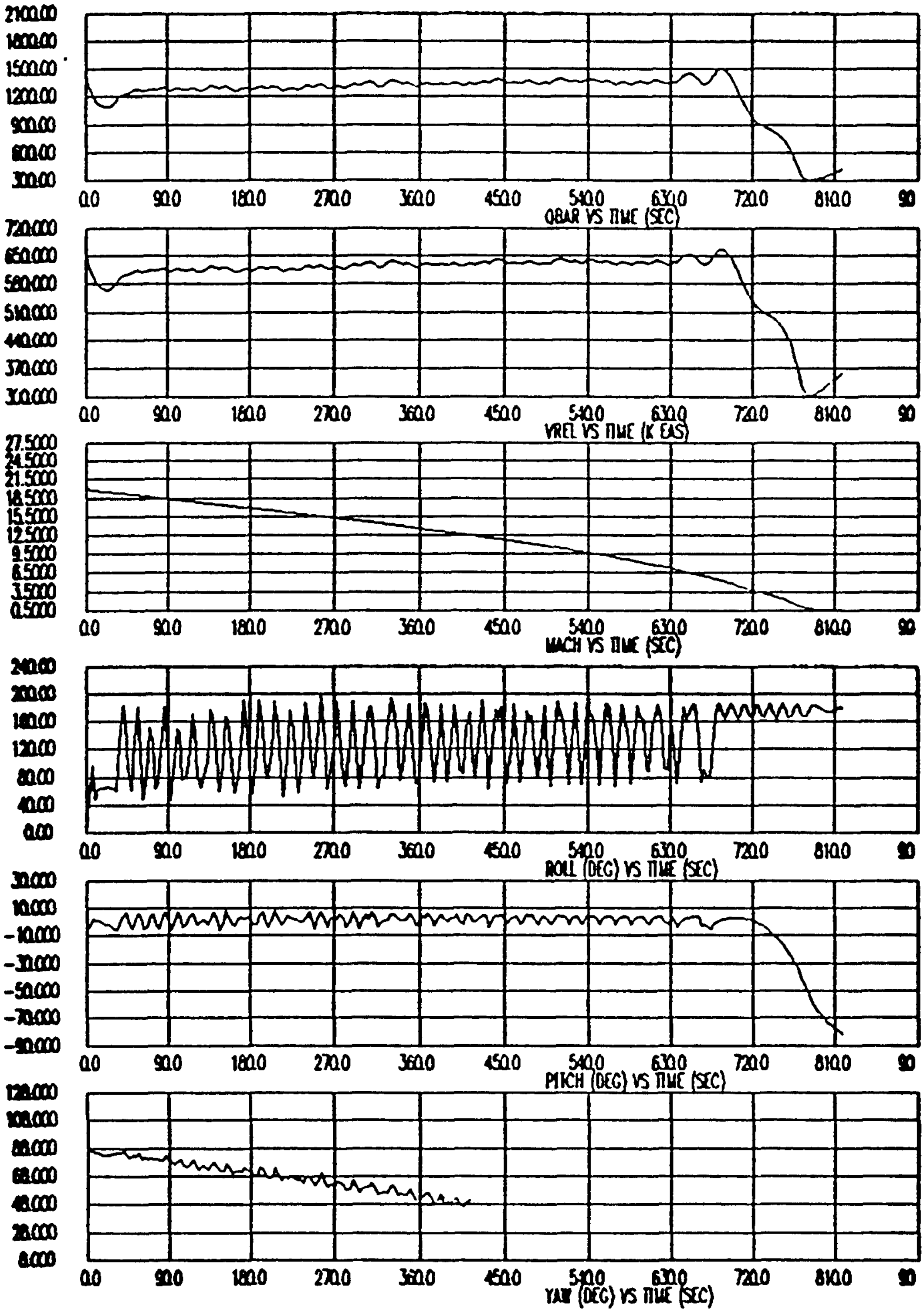


1000.0
700.0
400.0
100.0
-200.0
-500.0
-800.0
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
ROLL AERO MOMENT (FT-LB) VS TIME (SEC)
220000.
150000.
80000.
10000.
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
PITCH AERO MOMENT (FT- LB) VS TIME (SEC)
70000.
50000.
30000.
10000.
-10000.
-30000.
-50000.
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
YAW AERO MOMENT (FT-LB) VS TIME (SEC)
220.00
150.00
80.00
10.00
-60.00
-130.00
-200.00
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
ROLL CONTROL MOM (FT-LB) VS TIME (SEC)
1.0000
0.0000
-1.0000
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
PITCH CONTROL MOM (FT-LB) VS TIME (SEC)
1.0000
0.0000
-1.0000
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0 1600.0 1800.0 200
YAW CONTROL MOM (FT-LB) VS TIME (SEC)

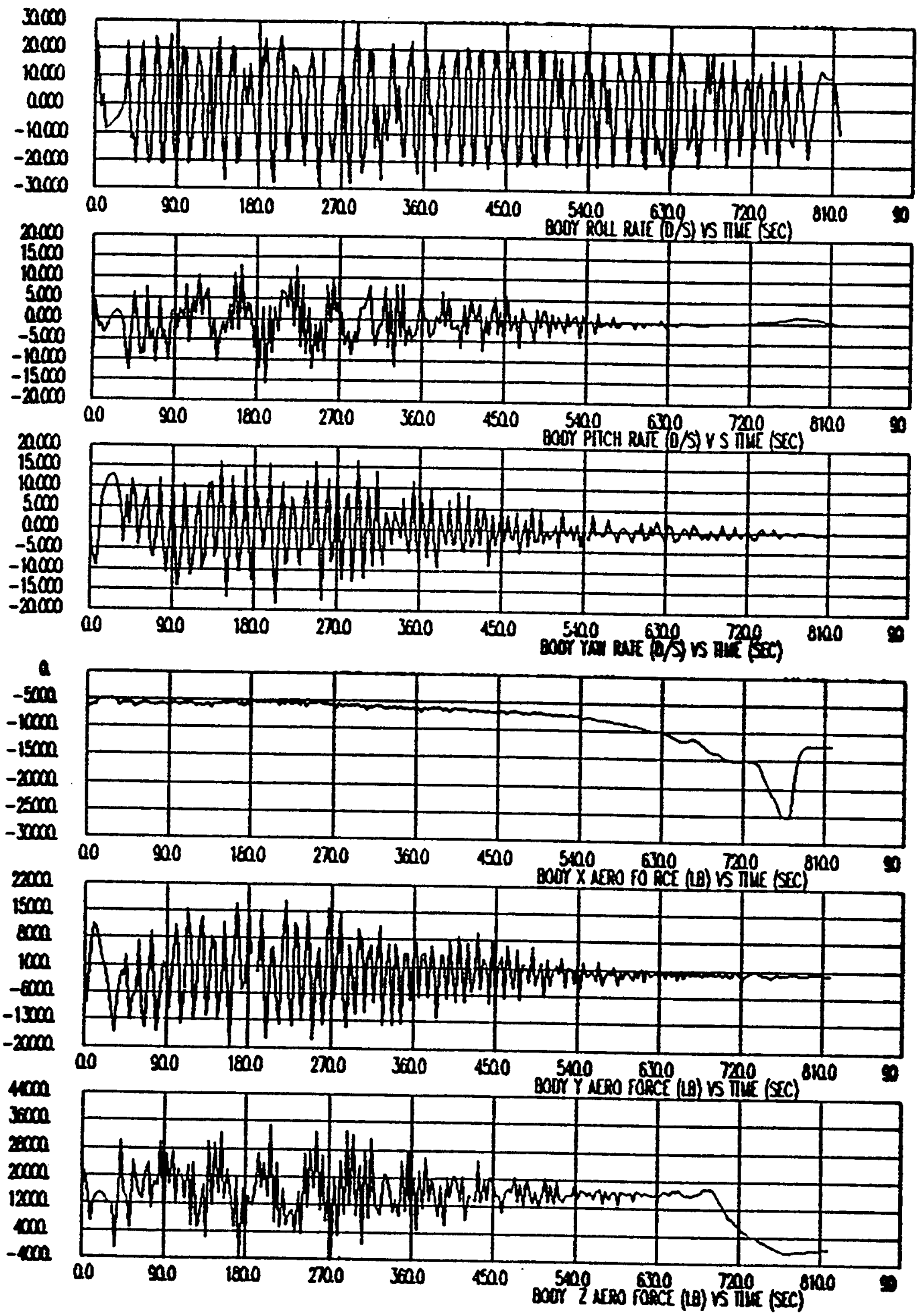
Case 2


100.000
96.000
92.000
88.000
84.000
80.000
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1400.0
1600.0
1800.0
200
AZIMUTH (DEG) VS TIME (SEC)
4.0000
2.0000
0.0000
-2.0000
-4.0000
-6.0000
CREW X ACCEL (G) VS TIME (SEC)
2.0000
1.0000
0.0000
-1.0000
-2.0000
CREW Y ACCEL (G) VS TIME (SEC)
10.000
7.000
4.000
1.000
-2.000
-5.000
CREW Z ACCEL (G) VS TIME (SEC)

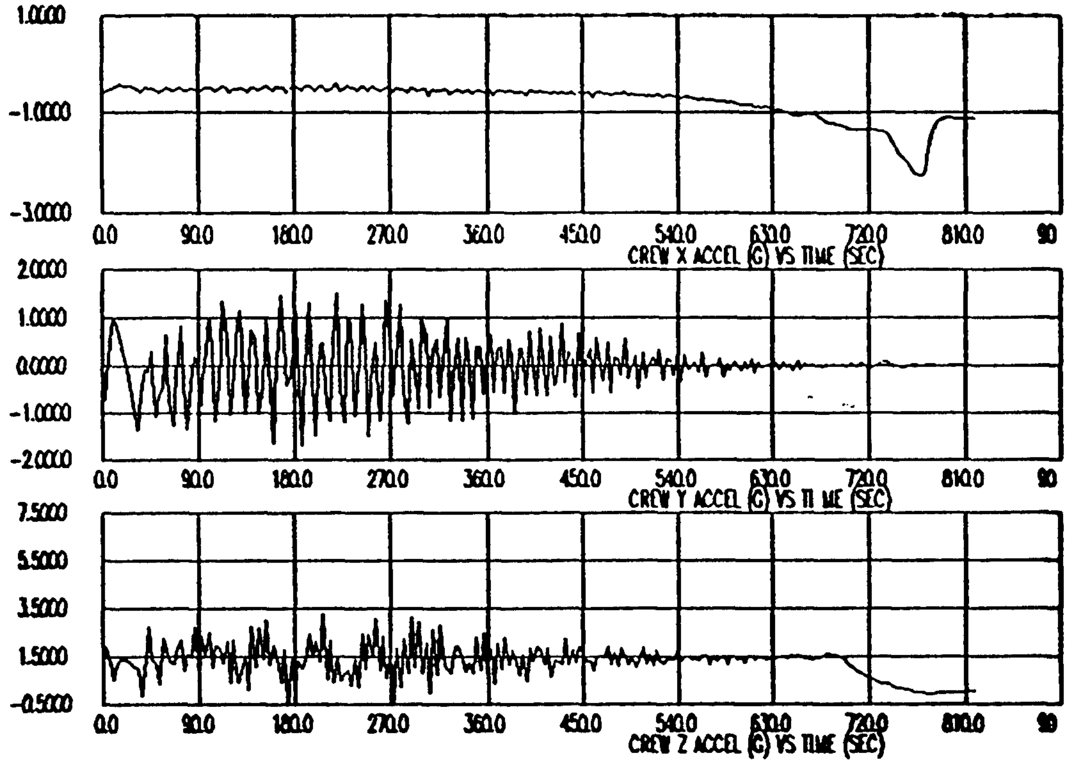

ALPHA (DEG) VS TIME (SEC)
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)


2100.00
1800.00
1500.00
1200.00
900.00
600.00
300.00
0.0 90.0 180.0 270.0 360.0 450.0 540.0 630.0 720.0 810.0 90
QBAR VS TIME (SEC)
720.000
650.000
580.000
510.000
440.000
370.000
300.000
0.0 90.0 180.0 270.0 360.0 450.0 540.0 630.0 720.0 810.0 90
VREL VS TIME (K EAS)
27.5000
24.5000
21.5000
18.5000
15.5000
12.5000
9.5000
6.5000
3.5000
0.5000
0.0 90.0 180.0 270.0 360.0 450.0 540.0 630.0 720.0 810.0 90
MACH VS TIME (SEC)
240.00
200.00
160.00
120.00
80.00
40.00
0.00
0.0 90.0 180.0 270.0 360.0 450.0 540.0 630.0 720.0 810.0 90
ROLL (DEG) VS TIME (SEC)
30.000
10.000
-10.000
-30.000
-50.000
-70.000
-90.000
0.0 90.0 180.0 270.0 360.0 450.0 540.0 630.0 720.0 810.0 90
PITCH (DEG) VS TIME (SEC)
128.000
108.000
88.000
68.000
48.000
28.000
8.000
0.0 90.0 180.0 270.0 360.0 450.0 540.0 630.0 720.0 810.0 90
YAW (DEG) VS TIME (SEC)

Case 3

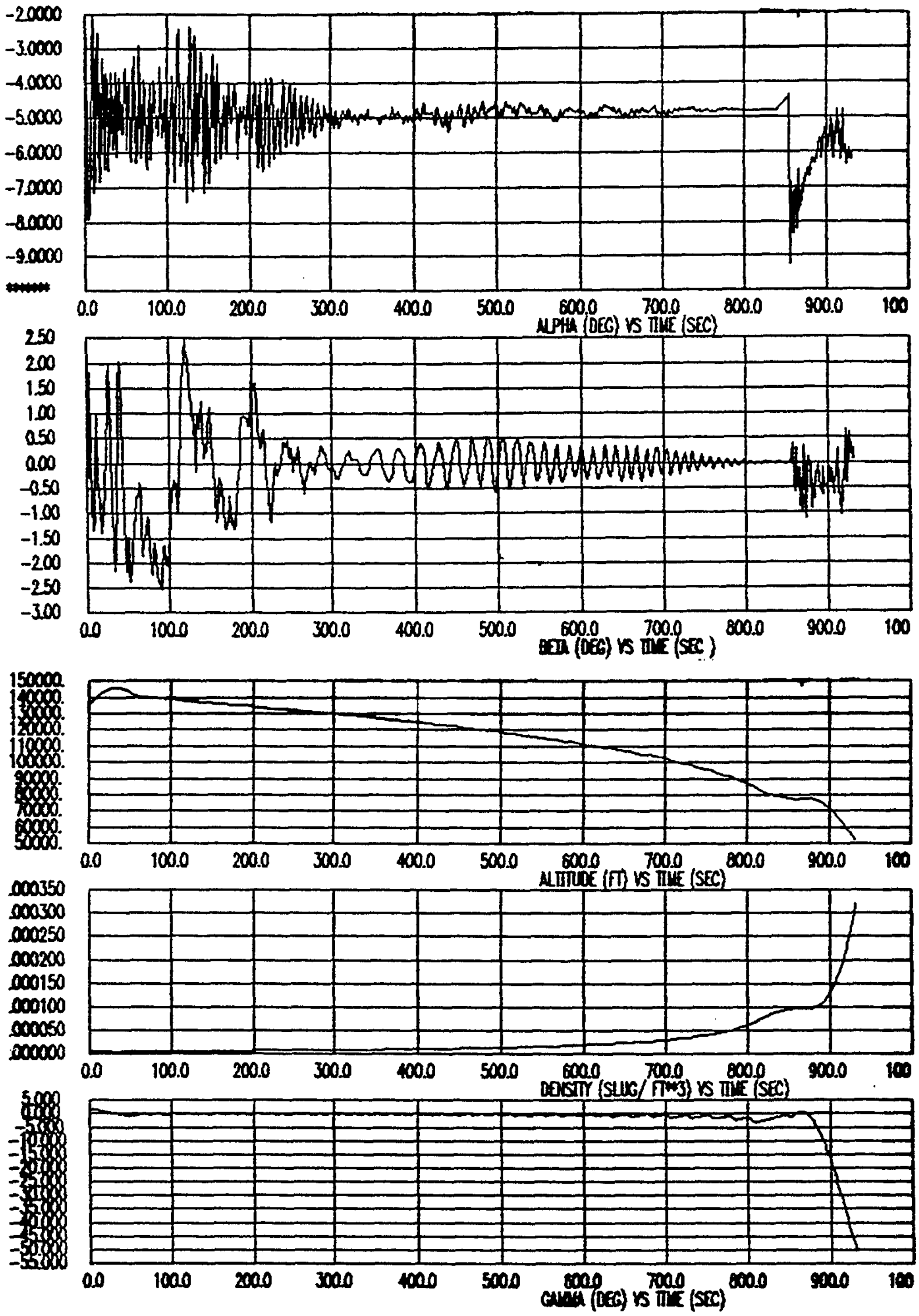

BODY ROLL RATE (D/S) VS TIME (SEC)
BODY PITCH RATE (D/S) V S TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)
BODY X AERO FO RCE (LB) VS TIME (SEC)
BODY Y AERO FORCE (LB) VS TIME (SEC)
BODY Z AERO FORCE (LB) VS TIME (SEC)

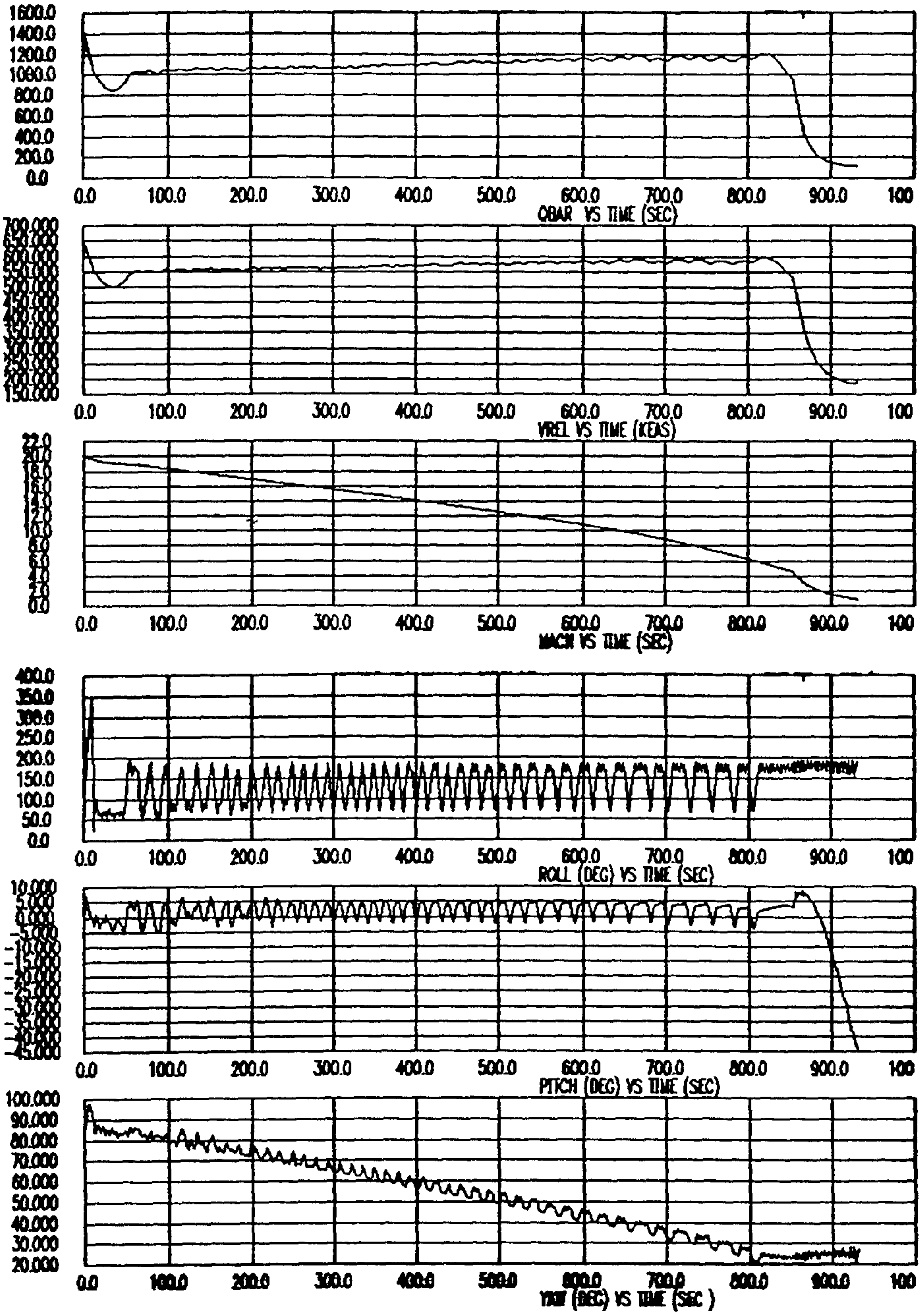
Case 3

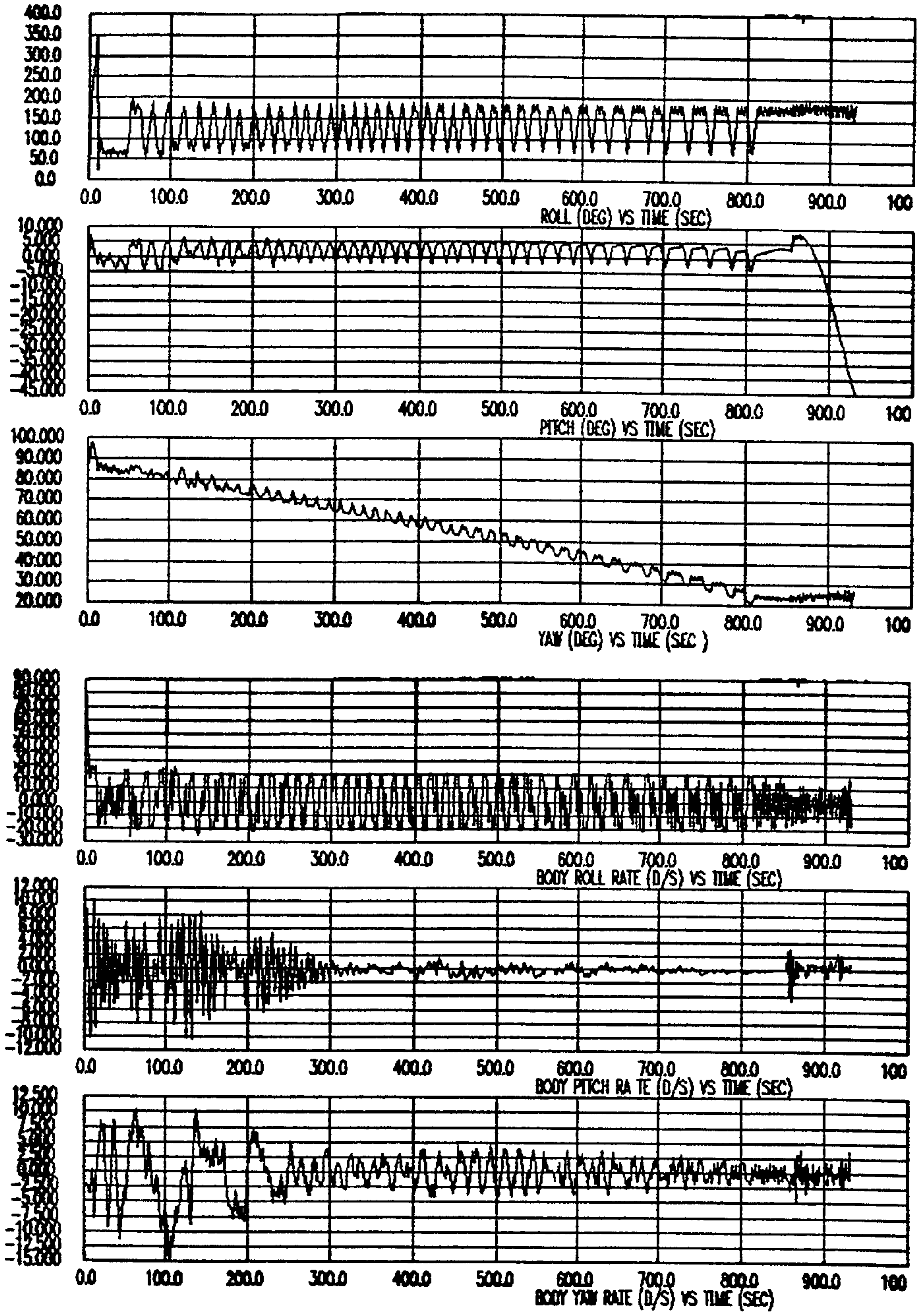


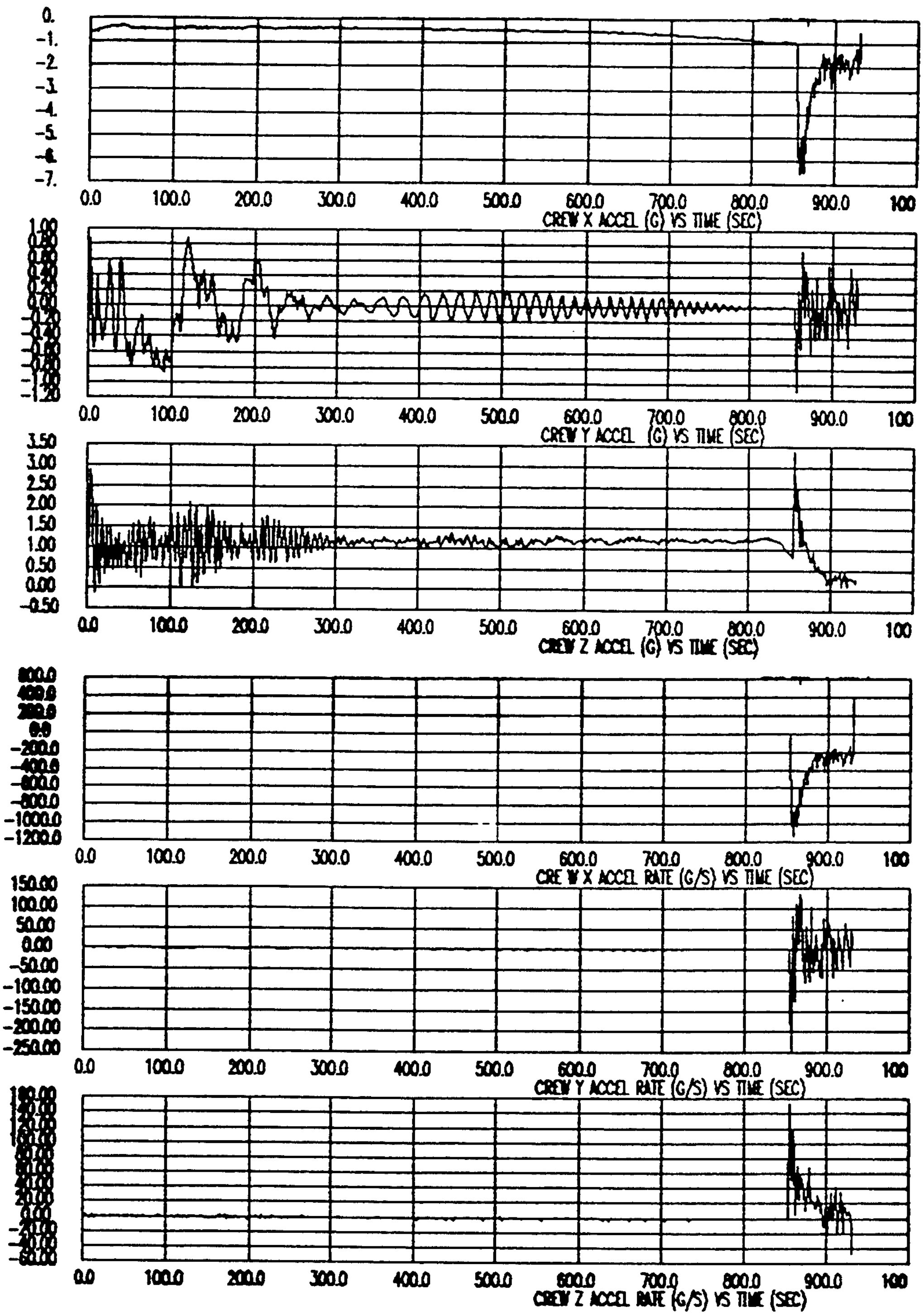
1.0000
-1.0000
-3.0000
0.0
90.0
180.0
270.0
360.0
450.0
540.0
630.0
720.0
810.0
CREW X ACCEL (G) VS TIME (SEC)
2.0000
1.0000
0.0000
-1.0000
-2.0000
CREW Y ACCEL (G) VS TIME (SEC)
7.5000
5.5000
3.5000
1.5000
-0.5000
CREW Z ACCEL (G) VS TIME (SEC)

Case 4

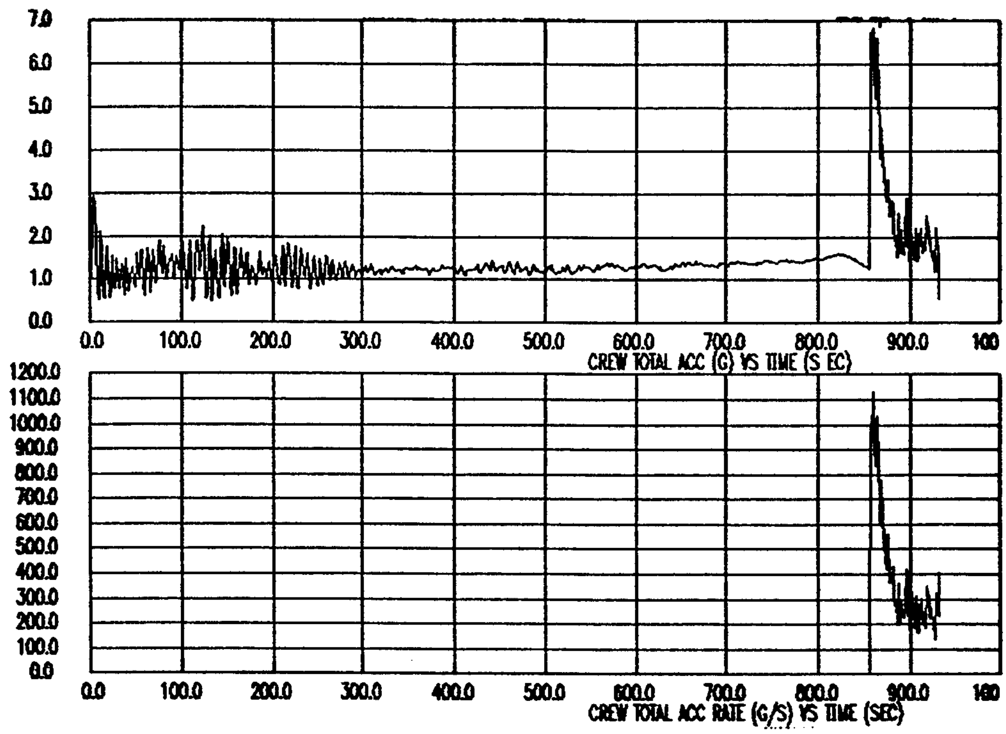

ALPHA (DEG) VS TIME (SEC)
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/ FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
900.0
100

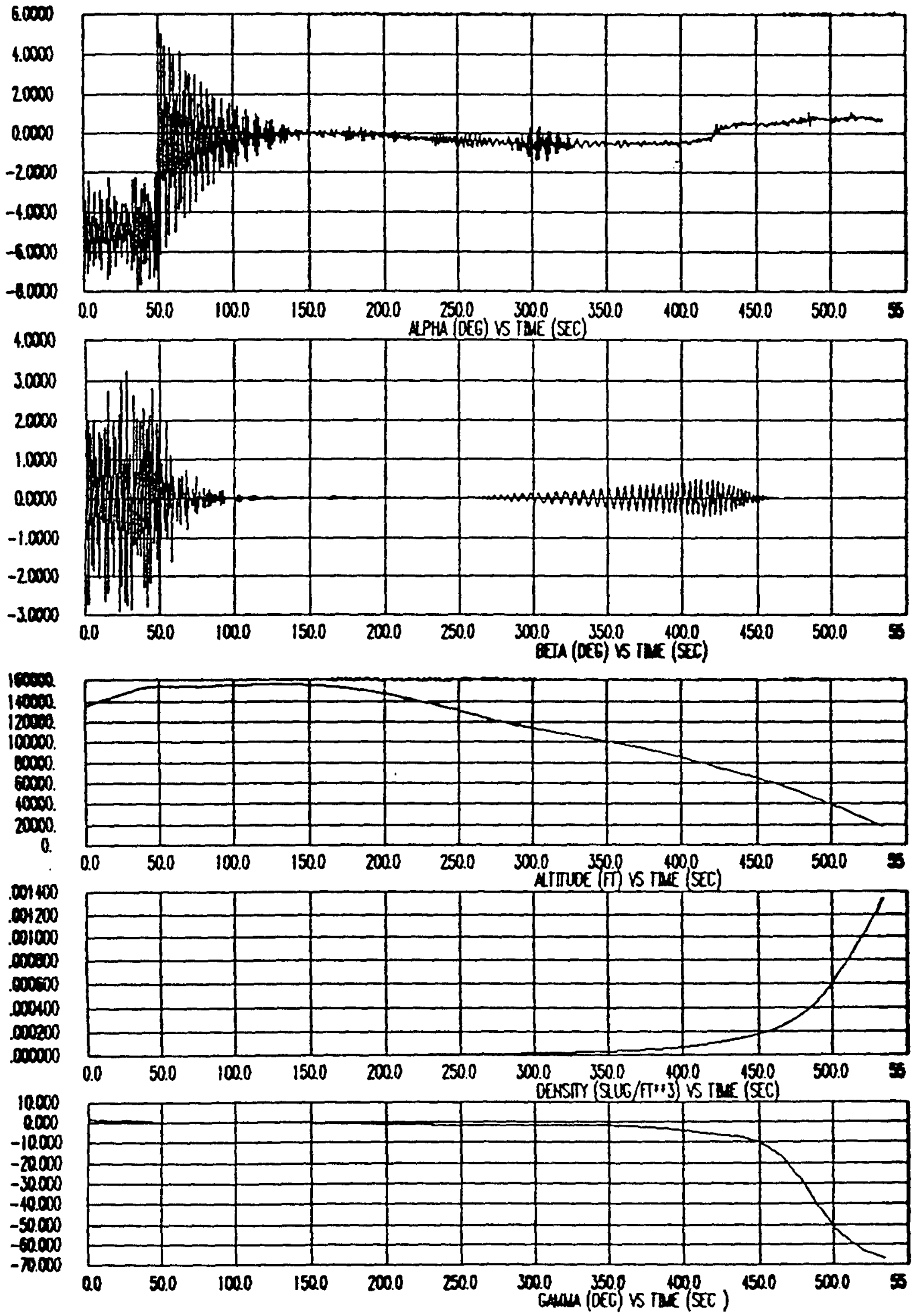

QBAR VS TIME (SEC)
VREL VS TIME (KEAS)
MACH VS TIME (SEC)
ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
1600.0 1400.0 1200.0 1000.0 800.0 600.0 400.0 200.0 0.0
400.0 350.0 300.0 250.0 200.0 150.0 100.0 50.0 0.0
100.000 90.000 80.000 70.000 60.000 50.000 40.000 30.000 20.000

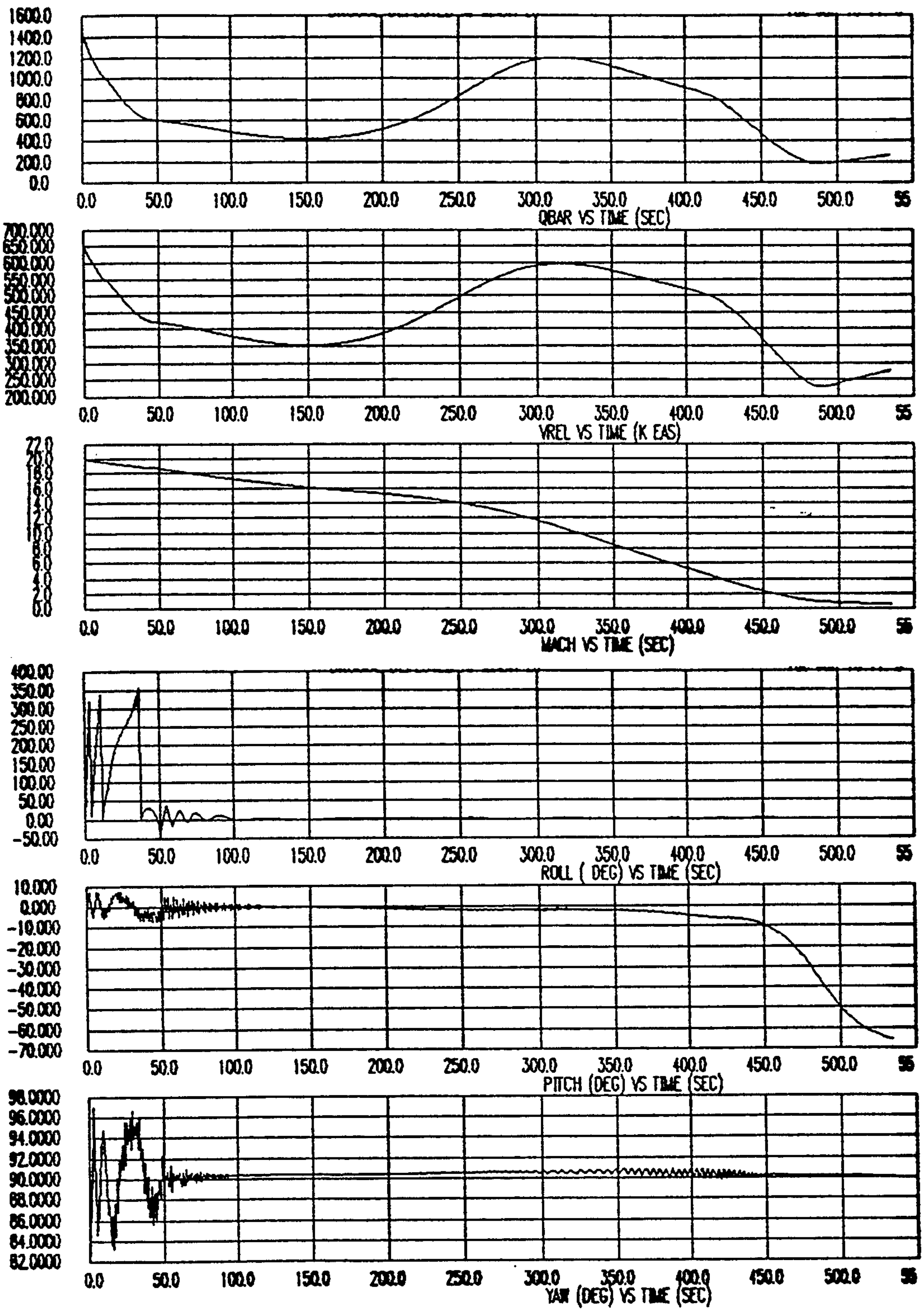

ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)
BODY ROLL RATE (D/S) VS TIME (SEC)
BODY PITCH RA TE (D/S) VS TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)


CREW X ACCEL (G) VS TIME (SEC)
CREW Y ACCEL (G) VS TIME (SEC)
CREW Z ACCEL (G) VS TIME (SEC)
CREW X ACCEL RATE (G/S) VS TIME (SEC)
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
CREW Z ACCEL RATE (G/S) VS TIME (SEC)

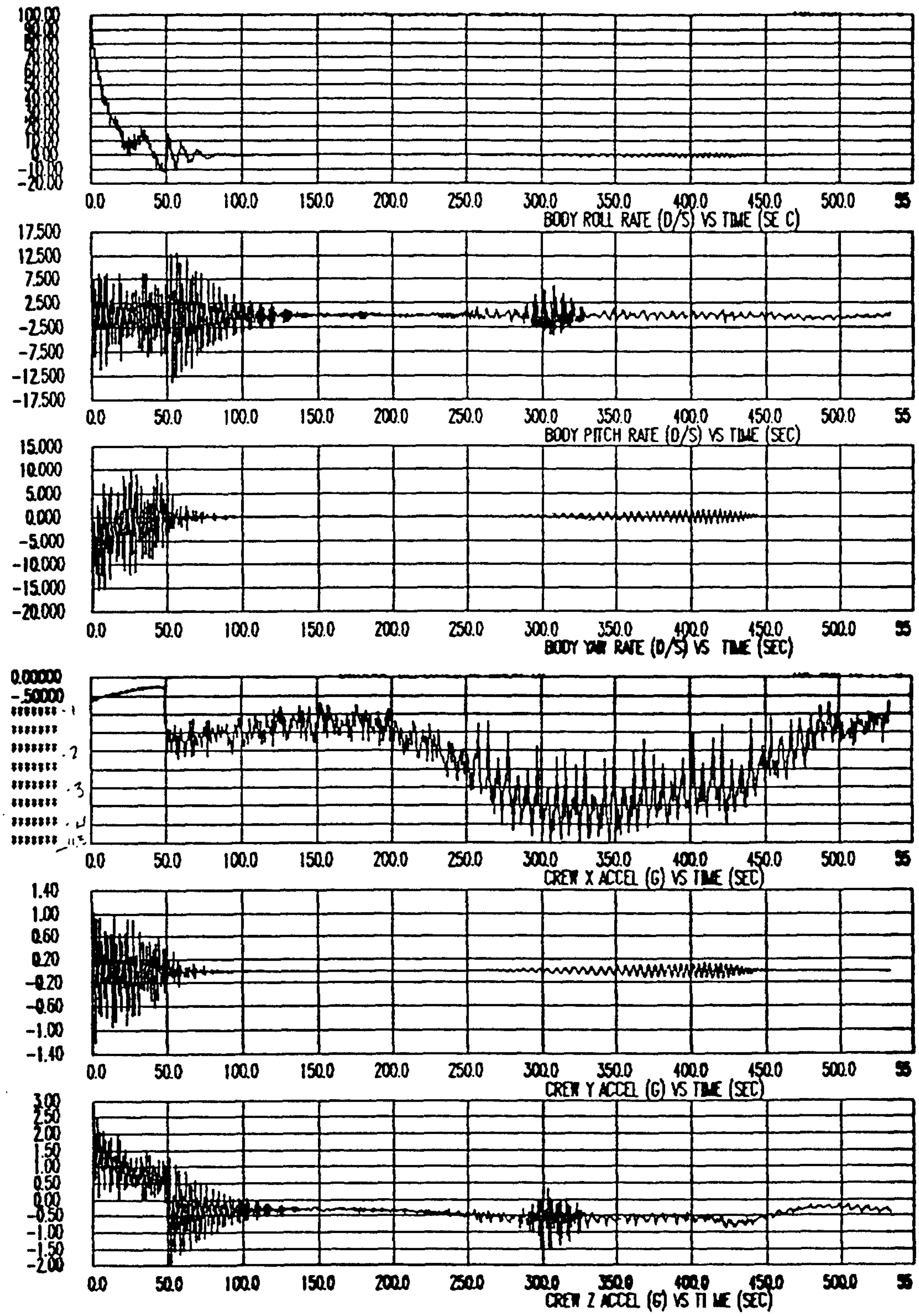
Case 4


7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
900.0
CREW TOTAL ACC (G) VS TIME (S EC)
1200.0
1100.0
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
900.0
CREW TOTAL ACC RATE (G/S) VS TIME (SEC)

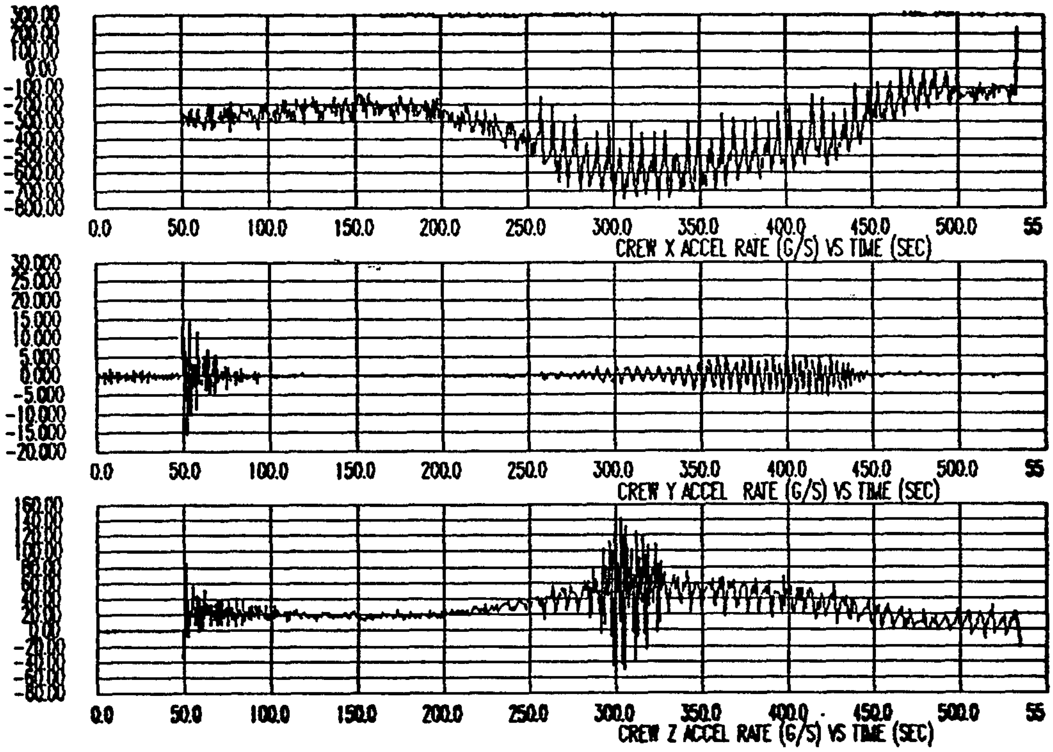

ALPHA (DEG) VS TIME (SEC)
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)

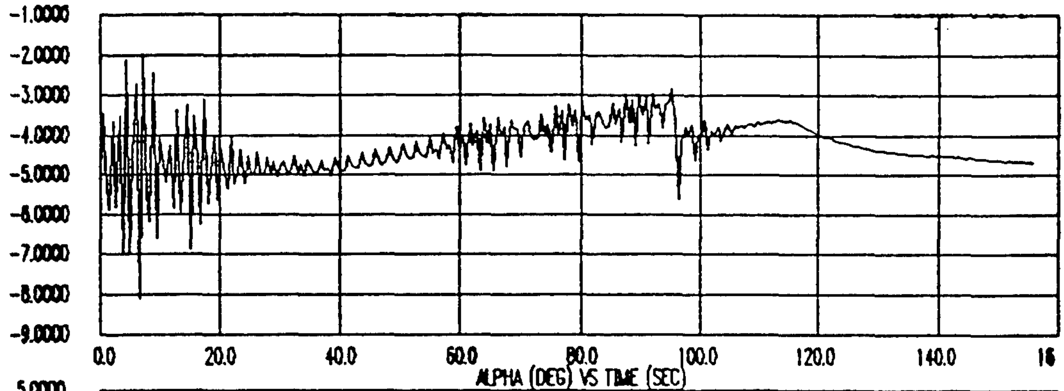

QBAR VS TIME (SEC)
VREL VS TIME (K EAS)
MACH VS TIME (SEC)
ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)

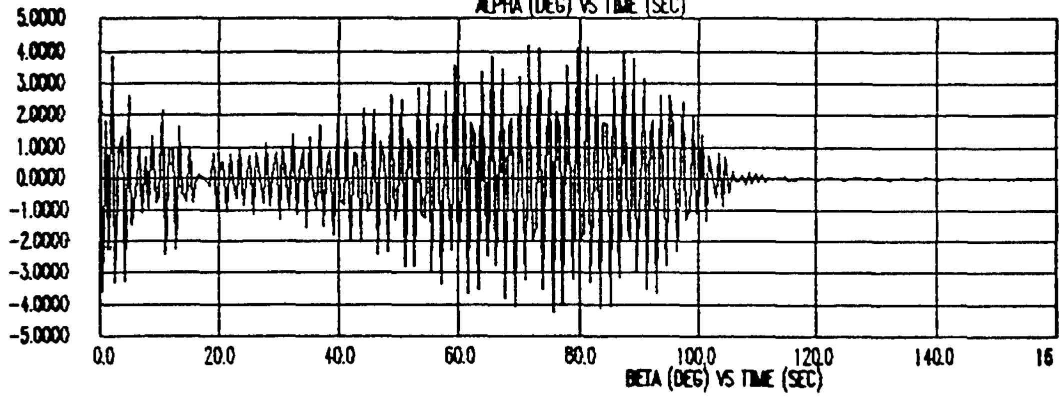
Case 5

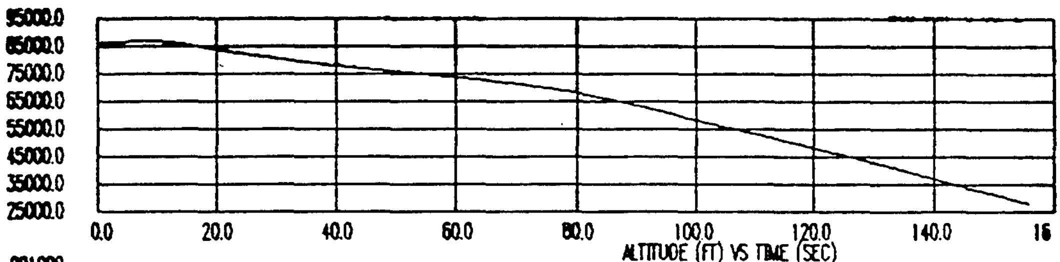

BODY ROLL RATE (D/S) VS TIME (SEC)
BODY PITCH RATE (D/S) VS TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)
CREW X ACCEL (G) VS TIME (SEC)
CREW Y ACCEL (G) VS TIME (SEC)
CREW Z ACCEL (G) VS TIME (SEC)

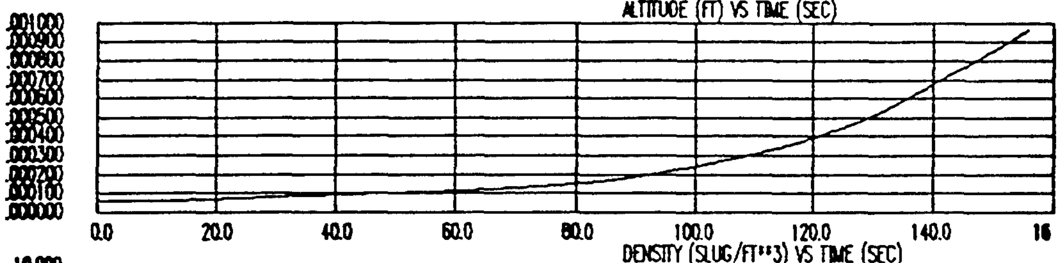
Case 5

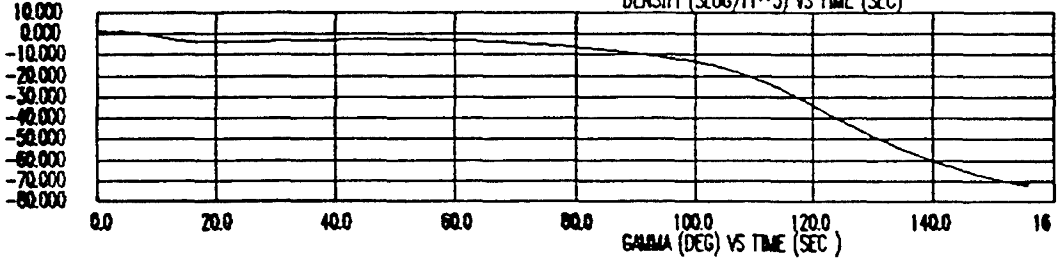

CREW X ACCEL RATE (G/S) VS TIME (SEC)
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
CREW Z ACCEL RATE (G/S) VS TIME (SEC)

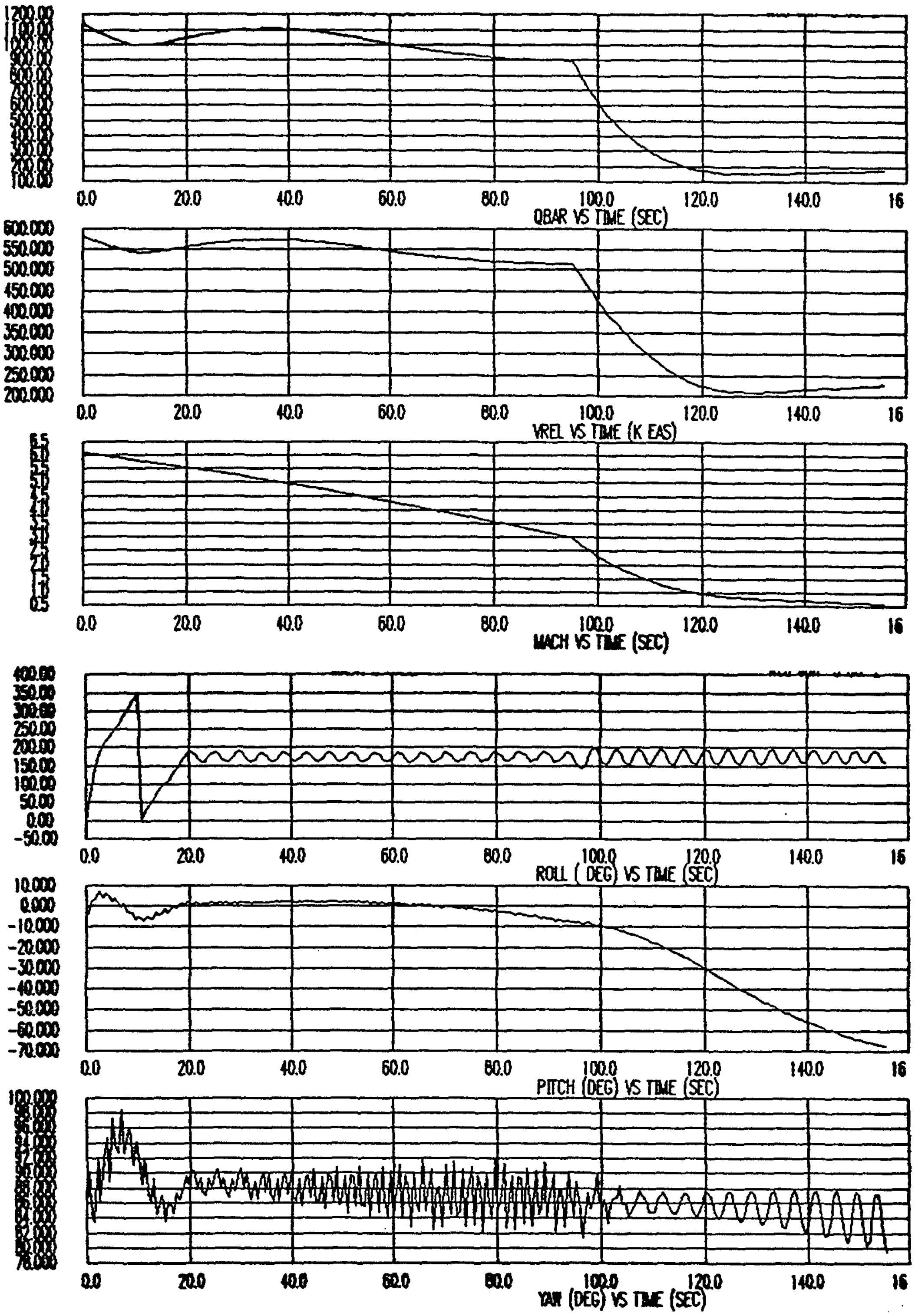

-1.0000
-2.0000
-3.0000
-4.0000
-5.0000
-6.0000
-7.0000
-8.0000
-9.0000
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
16
ALPHA (DEG) VS TIME (SEC)

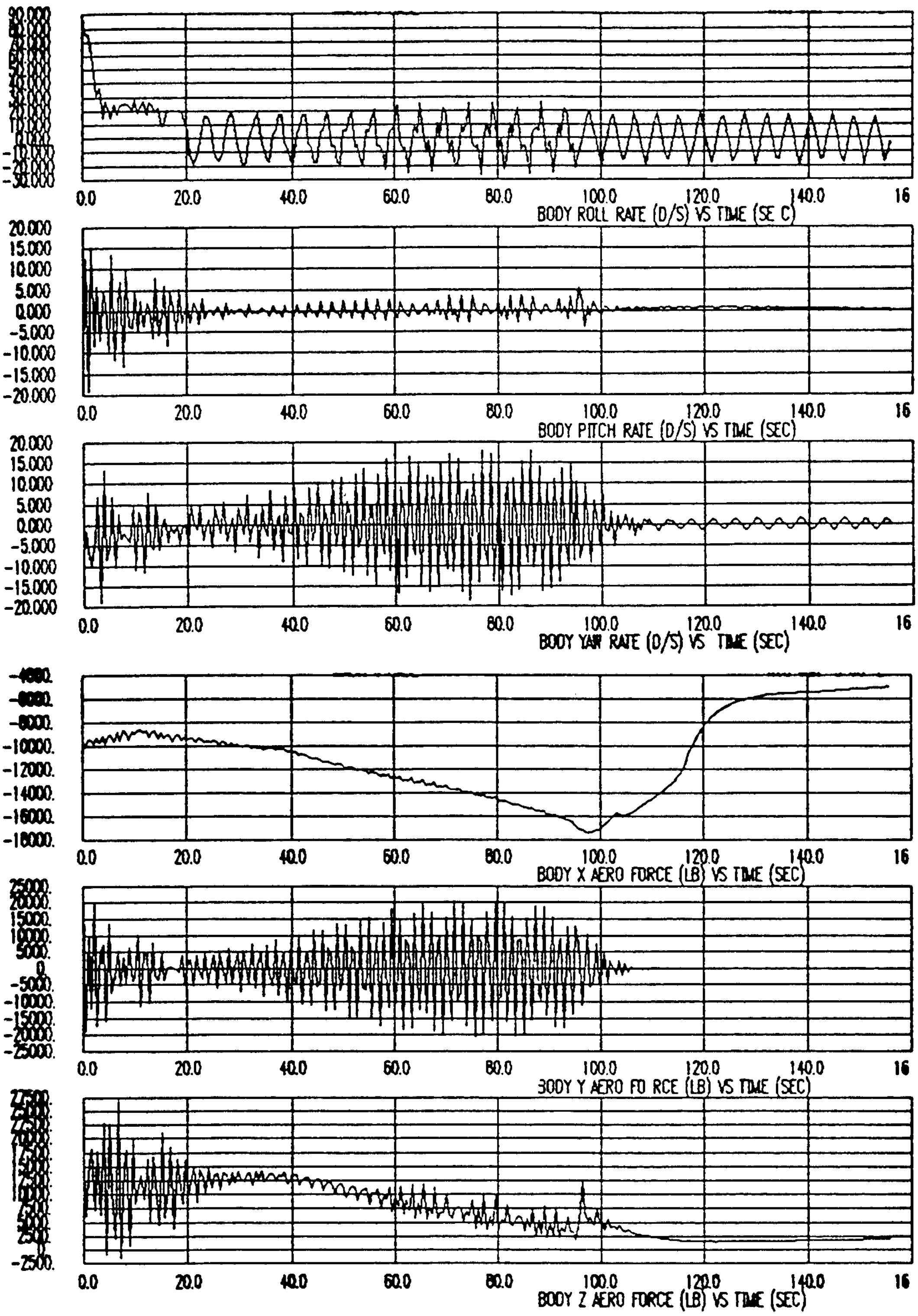

5.0000
4.0000
3.0000
2.0000
1.0000
0.0000
-1.0000
-2.0000
-3.0000
-4.0000
-5.0000
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
16
BETA (DEG) VS TIME (SEC)

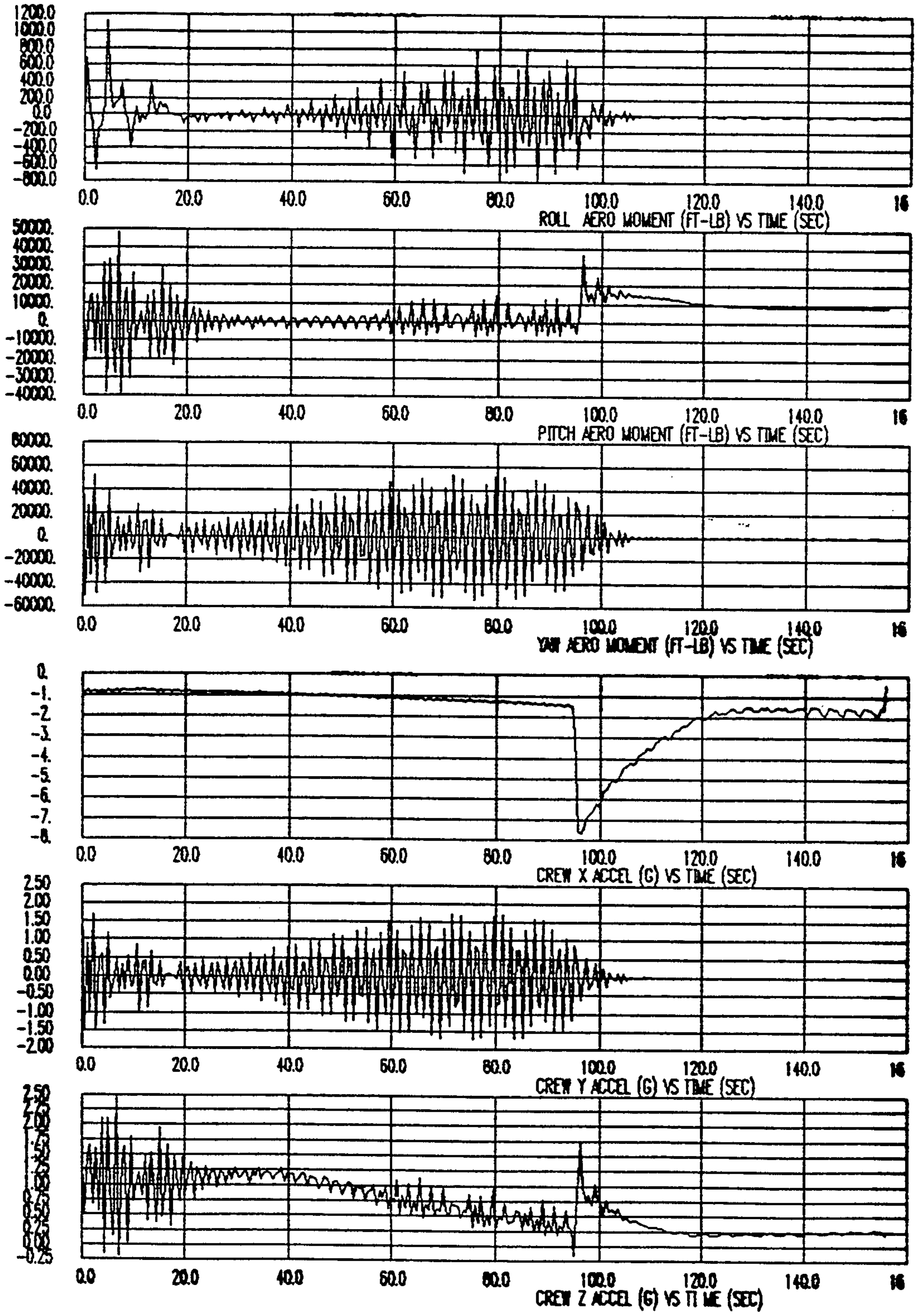

95000.0
85000.0
75000.0
65000.0
55000.0
45000.0
35000.0
25000.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
16
ALTITUDE (FT) VS TIME (SEC)

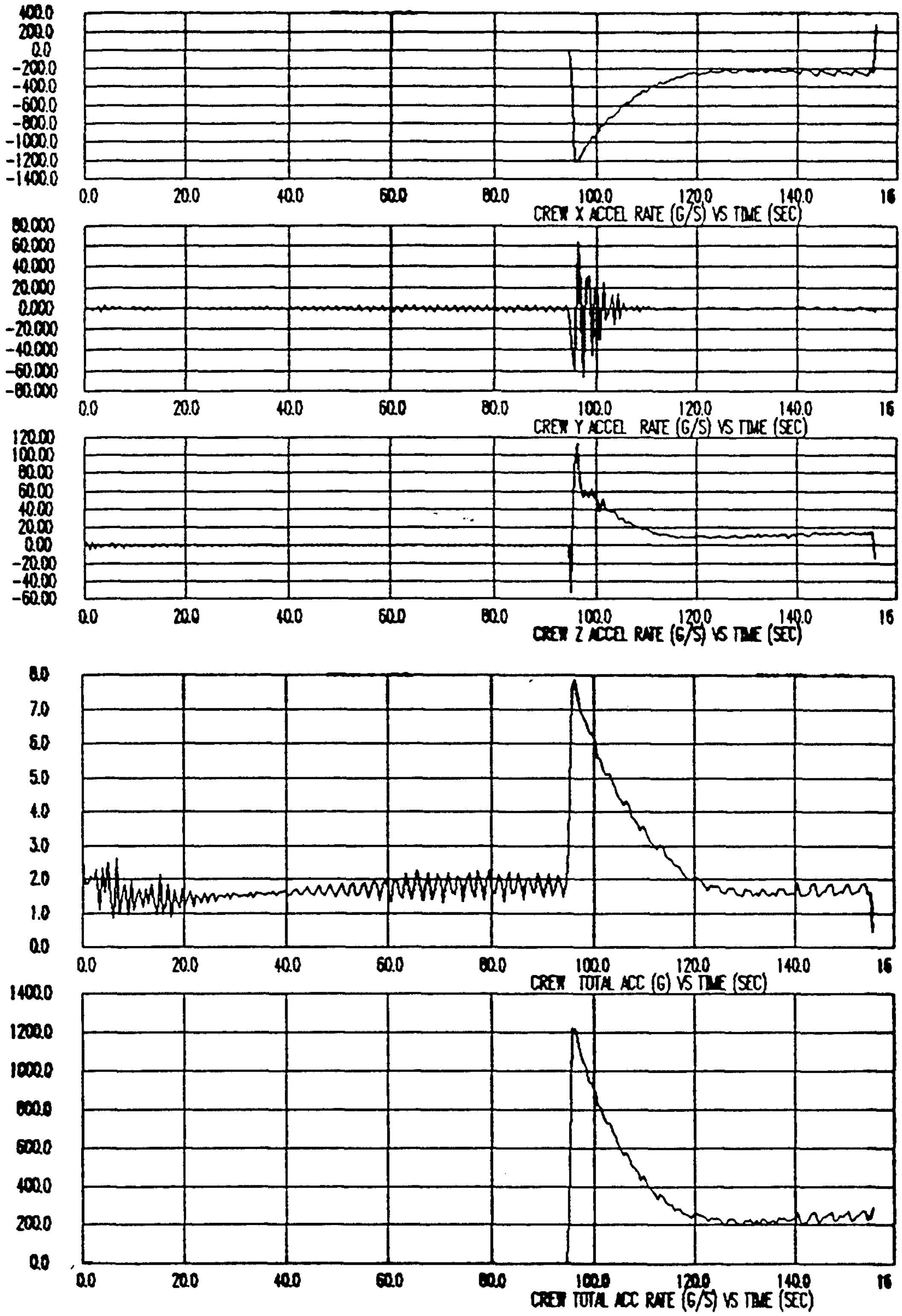

.001000
.000900
.000800
.000700
.000600
.000500
.000400
.000300
.000200
.000100
.000000
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
16
DENSITY (SLUG/FT**3) VS TIME (SEC)

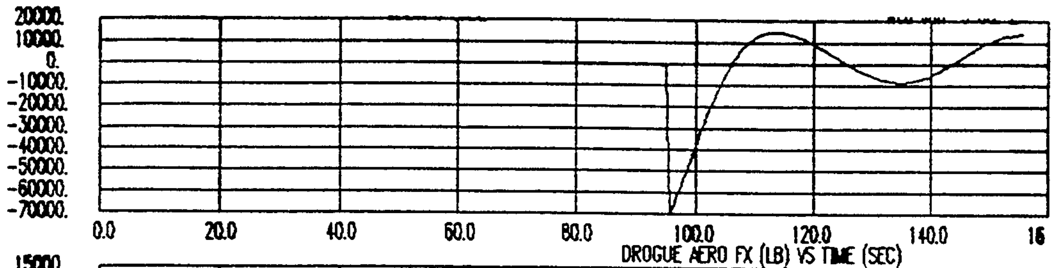

10.000
0.000
-10.000
-20.000
-30.000
-40.000
-50.000
-60.000
-70.000
-80.000
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
16
GAMMA (DEG) VS TIME (SEC)

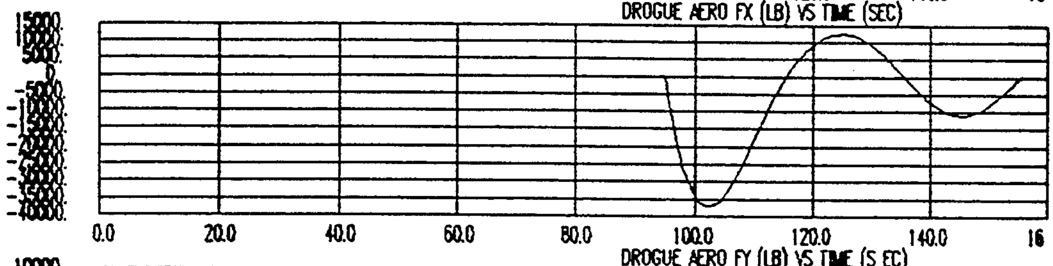

QBAR VS TIME (SEC)
VREL VS TIME (K EAS)
MACH VS TIME (SEC)
ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)
0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 16


BODY ROLL RATE (D/S) VS TIME (SEC)
BODY PITCH RATE (D/S) VS TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)
BODY X AERO FORCE (LB) VS TIME (SEC)
BODY Y AERO FORCE (LB) VS TIME (SEC)
BODY Z AERO FORCE (LB) VS TIME (SEC)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
16


ROLL AERO MOMENT (FT-LB) VS TIME (SEC)
PITCH AERO MOMENT (FT-LB) VS TIME (SEC)
YAW AERO MOMENT (FT-LB) VS TIME (SEC)
CREW X ACCEL (G) VS TIME (SEC)
CREW Y ACCEL (G) VS TIME (SEC)
CREW Z ACCEL (G) VS TIME (SEC)


CREW X ACCEL RATE (G/S) VS TIME (SEC)
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
CREW Z ACCEL RATE (G/S) VS TIME (SEC)
CREW TOTAL ACC (G) VS TIME (SEC)
CREW TOTAL ACC RATE (G/S) VS TIME (SEC)
0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 16


20000.
10000.
0.
-10000.
-20000.
-30000.
-40000.
-50000.
-60000.
-70000.
0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 16
DROGUE AERO FX (LB) VS TIME (SEC)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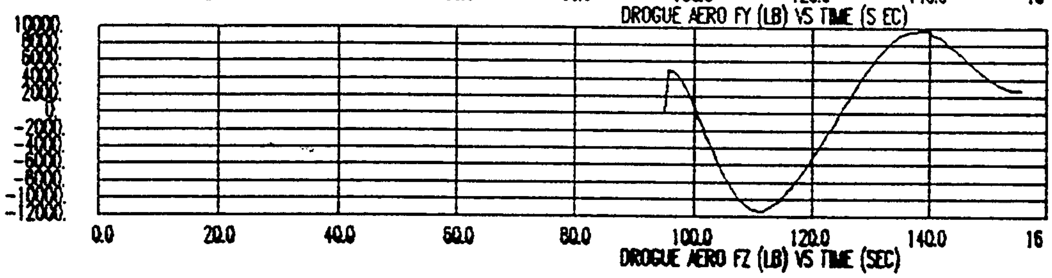
DROGUE AERO FY (LB) VS TIME (S EC)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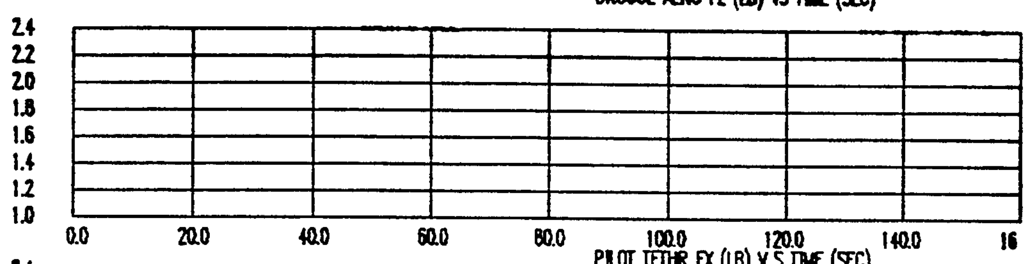
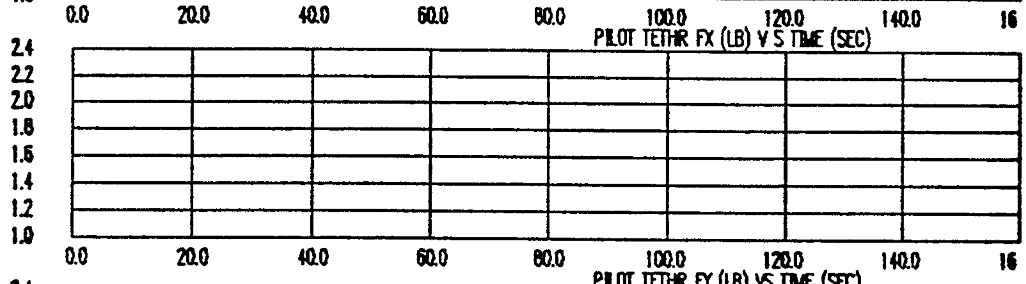
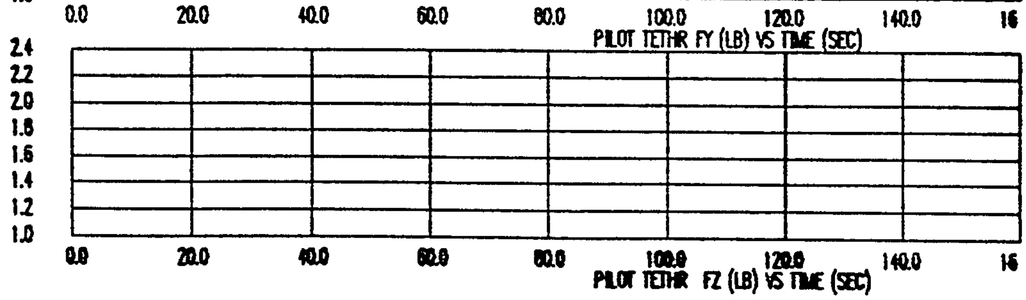
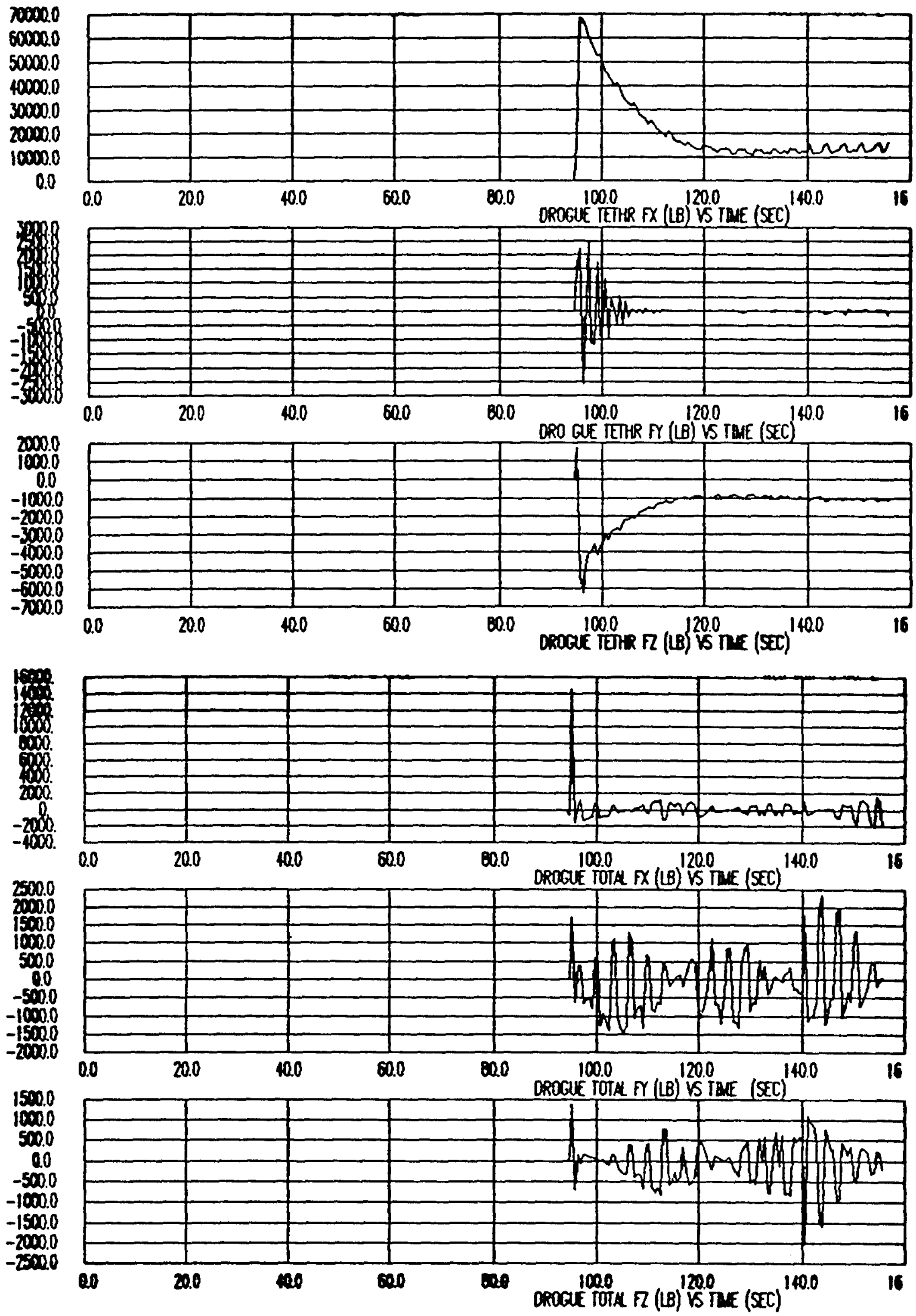
DROGUE AERO FZ (LB) VS TIME (SEC)

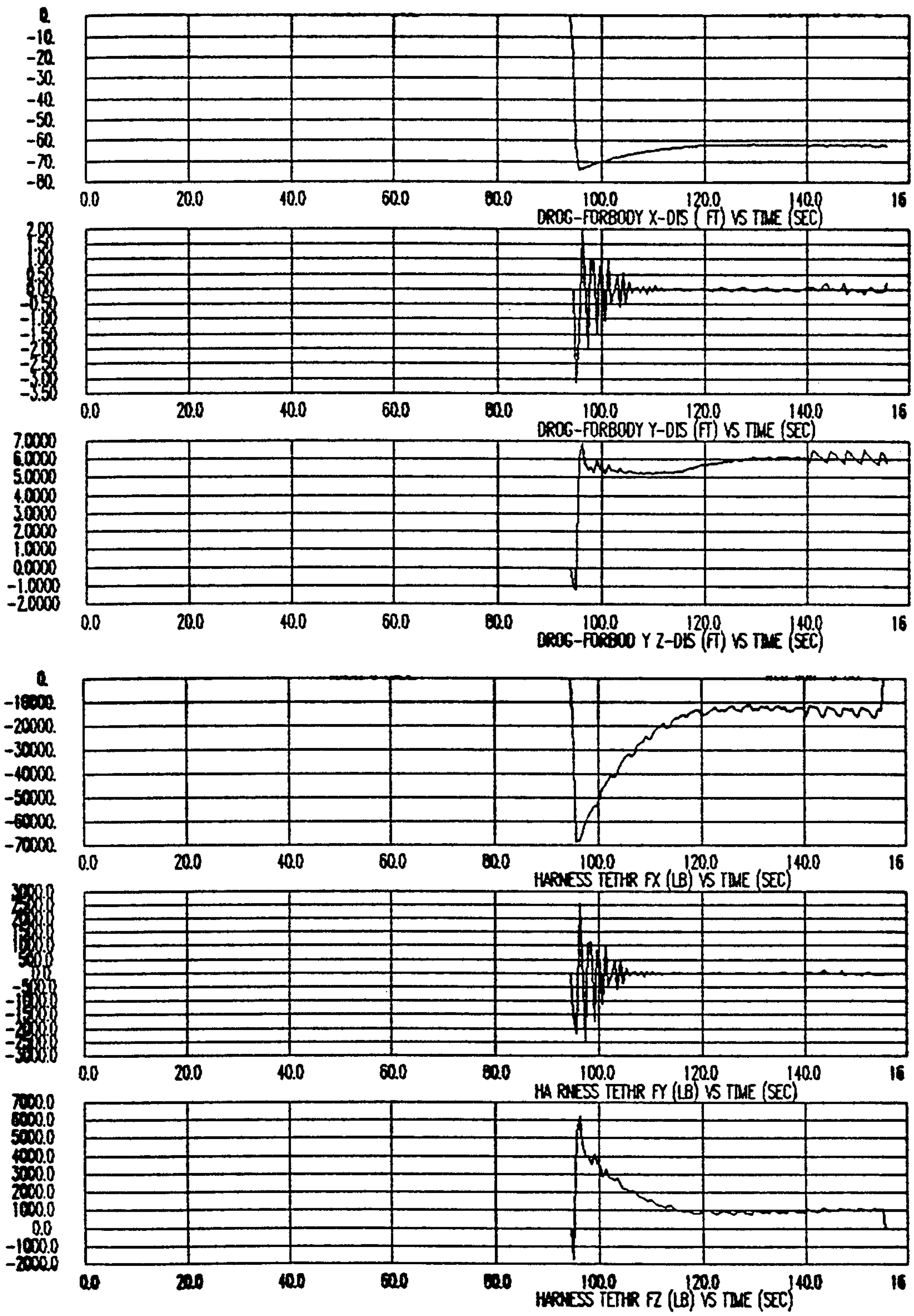

2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 16
PILOT TETHR FX (LB) V S TIME (SEC)


2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 16
PILOT TETHR FY (LB) VS TIME (SEC)

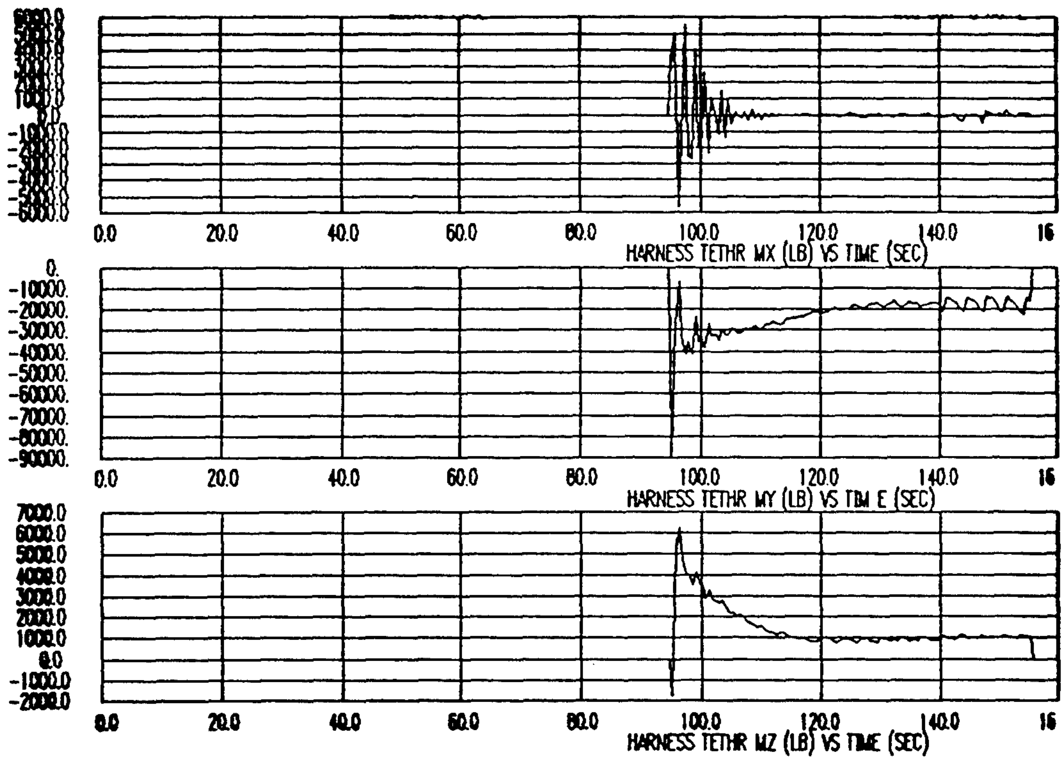

2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 16
PILOT TETHR FZ (LB) VS TIME (SEC)


DROGUE TETHR FX (LB) VS TIME (SEC)
DRO GUE TETHR FY (LB) VS TIME (SEC)
DROGUE TETHR FZ (LB) VS TIME (SEC)
DROGUE TOTAL FX (LB) VS TIME (SEC)
DROGUE TOTAL FY (LB) VS TIME (SEC)
DROGUE TOTAL FZ (LB) VS TIME (SEC)

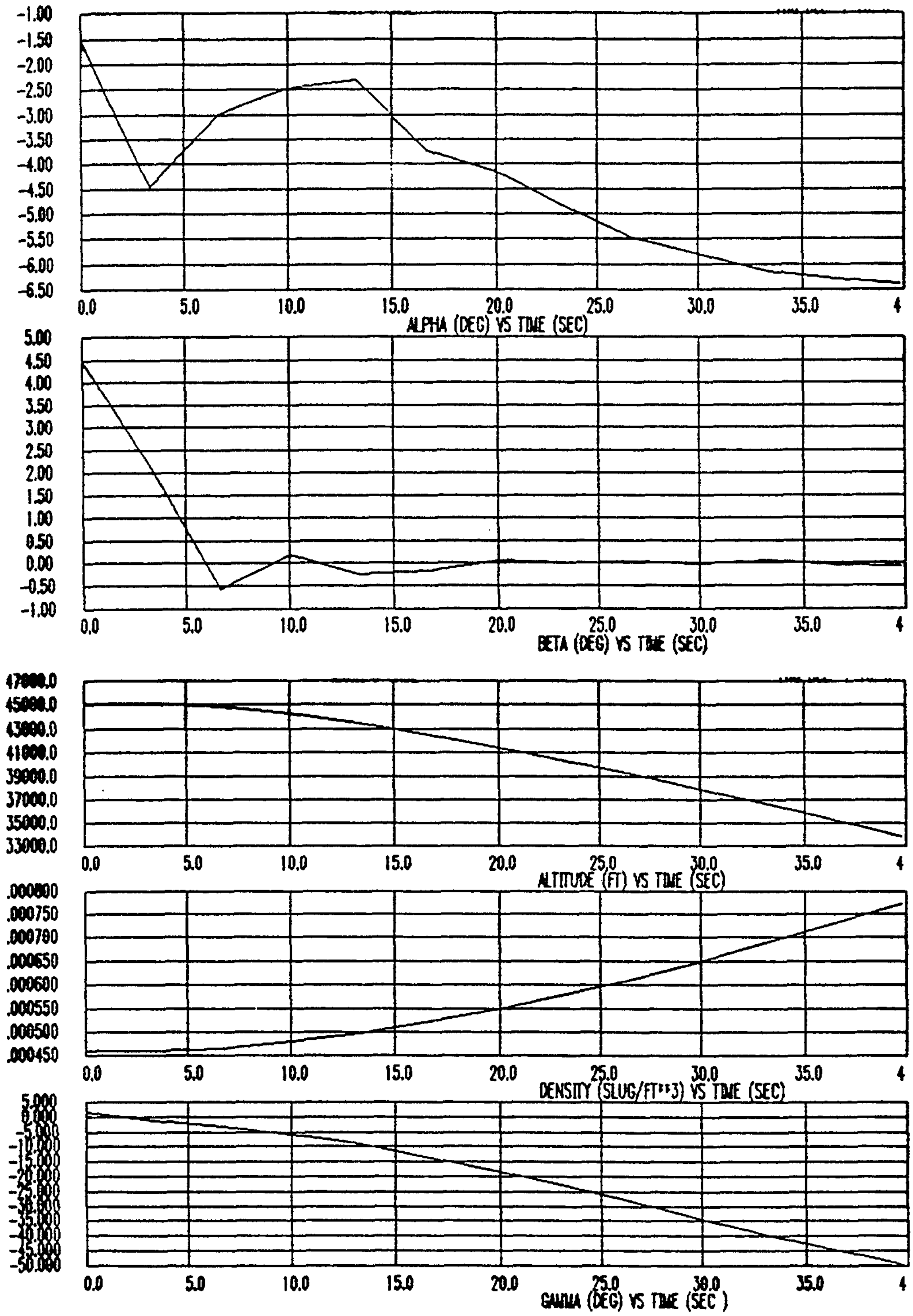
Case 6

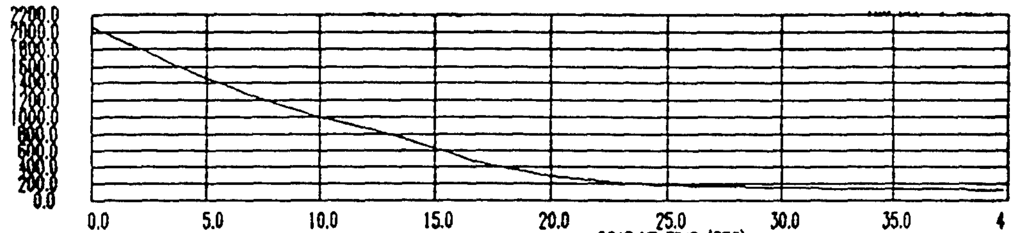

DROG-FORBODY X-DIS (FT) VS TIME (SEC)
DROG-FORBODY Y-DIS (FT) VS TIME (SEC)
DROG-FORBOD Y Z-DIS (FT) VS TIME (SEC)
HARNESS TETHR FX (LB) VS TIME (SEC)
HA RNESS TETHR FY (LB) VS TIME (SEC)
HARNESS TETHR FZ (LB) VS TIME (SEC)

Case 6

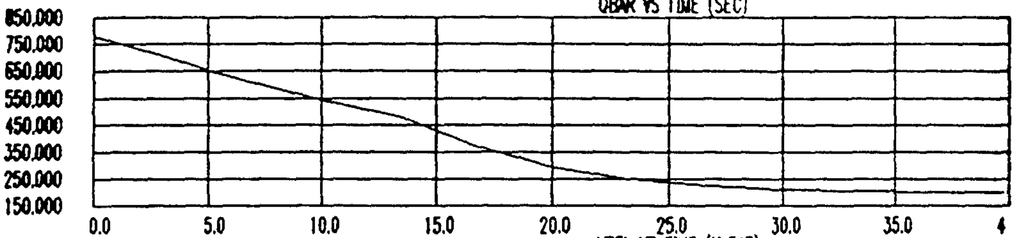


HARNESS TETHR MX (LB) VS TIME (SEC)
HARNESS TETHR MY (LB) VS TIM E (SEC)
HARNESS TETHR MZ (LB) VS TIME (SEC)

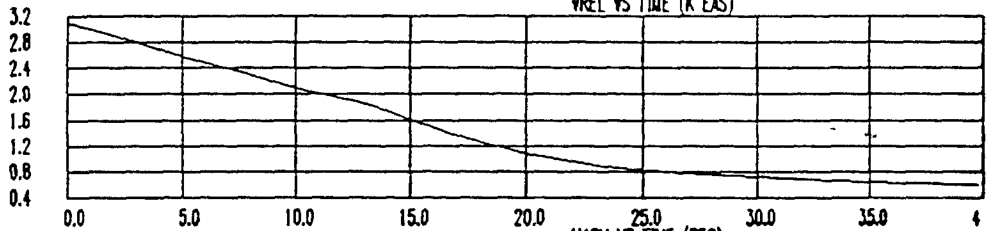

ALPHA (DEG) VS TIME (SEC)
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)



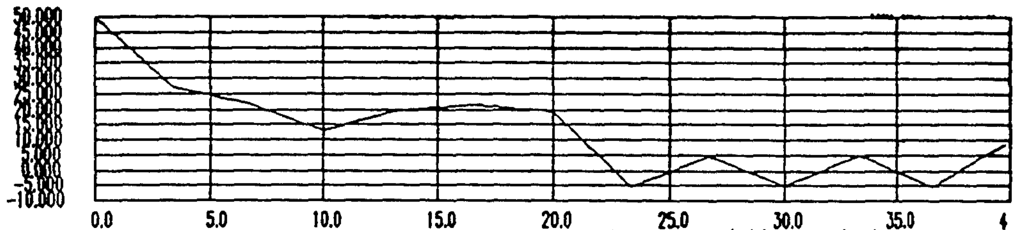
QBAR VS TIME (SEC)



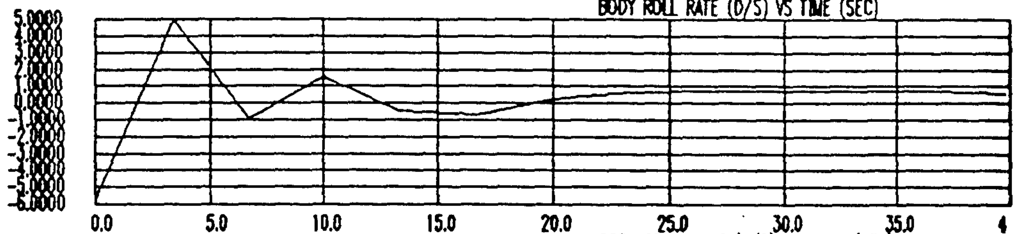
VREL VS TIME (K EAS)



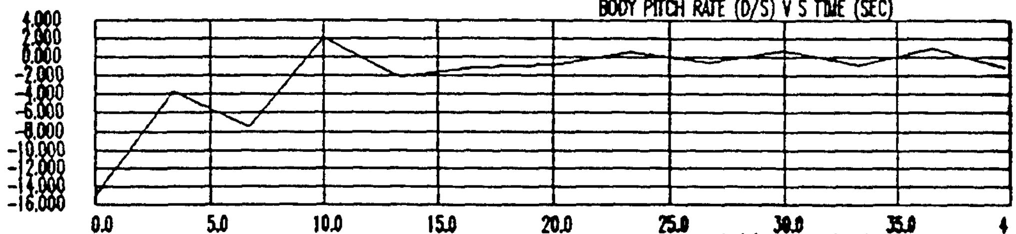
MACH VS TIME (SEC)



BODY ROLL RATE (D/S) VS TIME (SEC)

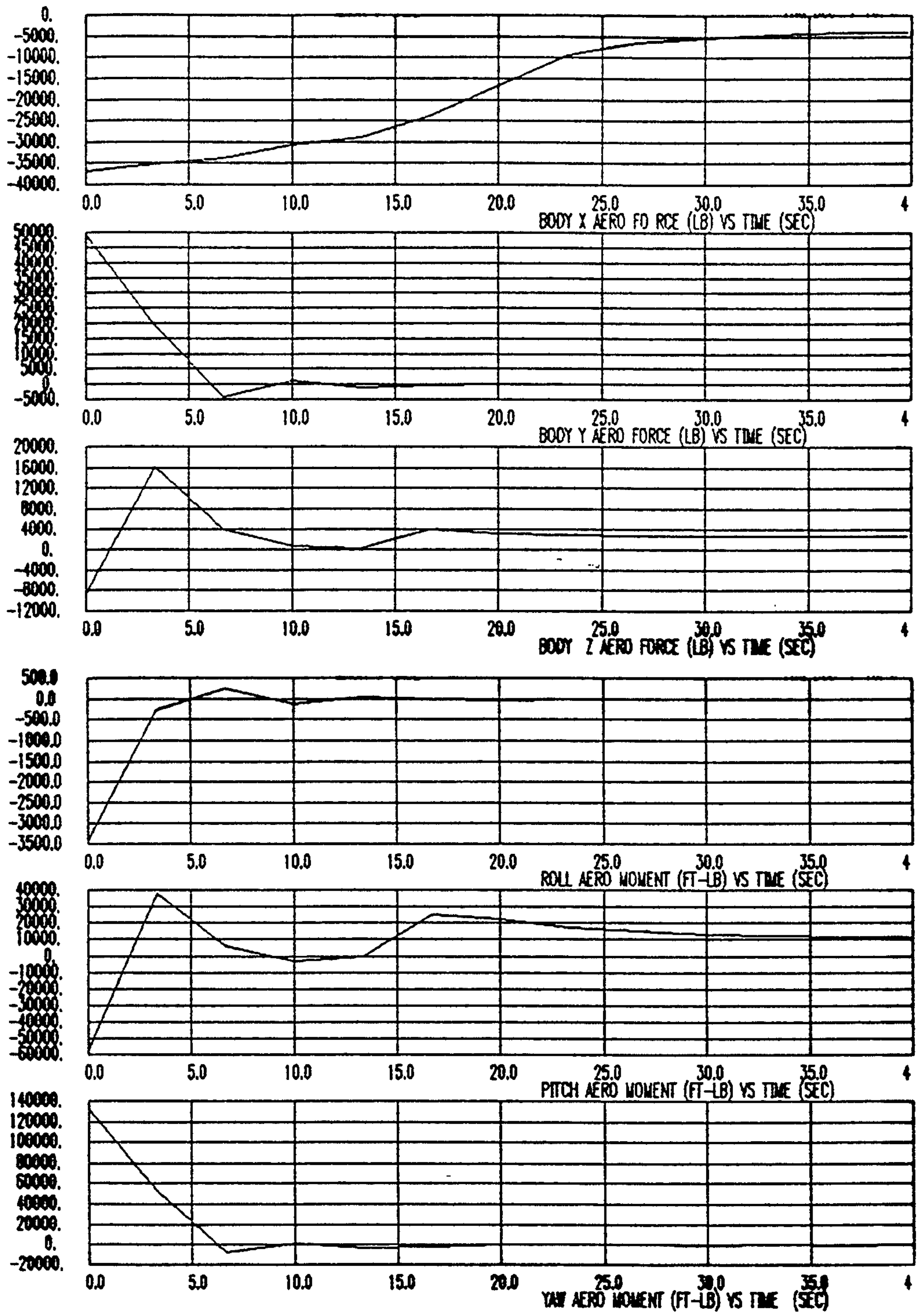


BODY PITCH RATE (D/S) V S TIME (SEC)

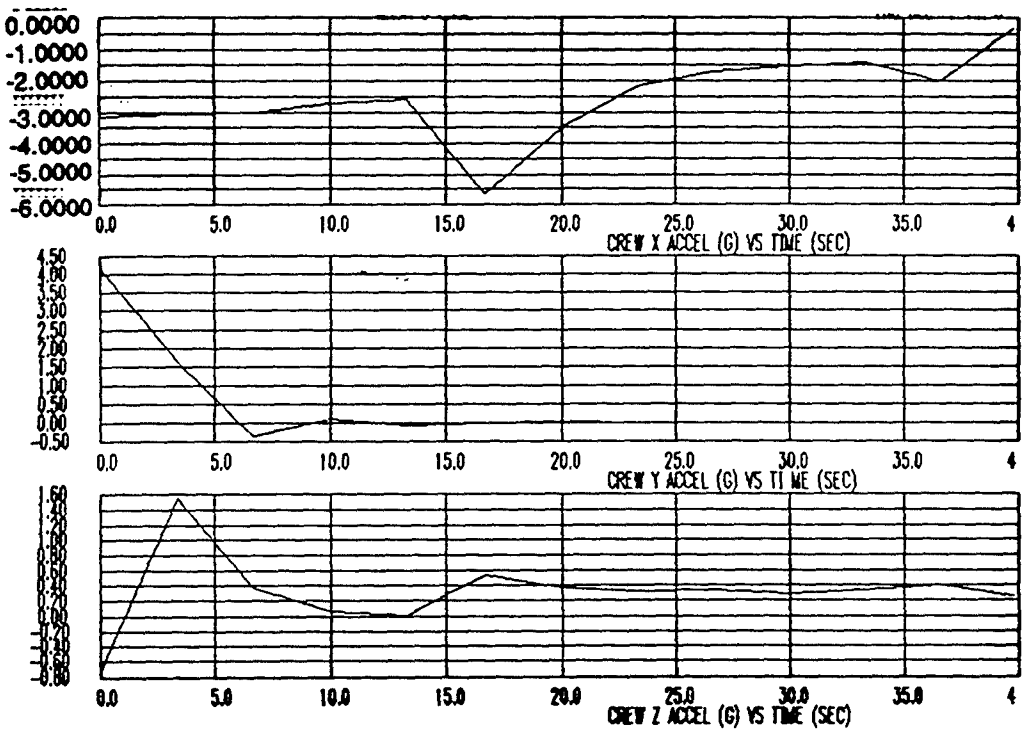


BODY YAW RATE (D/S) VS TIME (SEC)

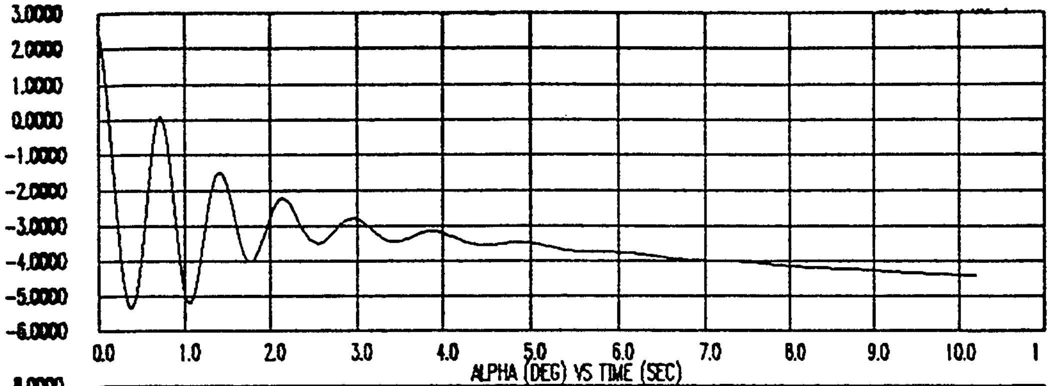
Case 7

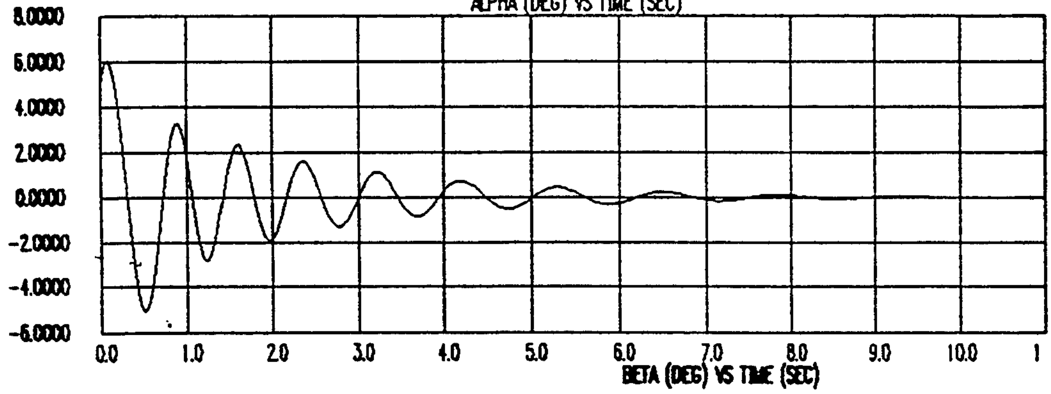

BODY X AERO FO RCE (LB) VS TIME (SEC)
BODY Y AERO FORCE (LB) VS TIME (SEC)
BODY Z AERO FORCE (LB) VS TIME (SEC)
ROLL AERO MOMENT (FT-LB) VS TIME (SEC)
PITCH AERO MOMENT (FT-LB) VS TIME (SEC)
YAW AERO MOMENT (FT-LB) VS TIME (SEC)

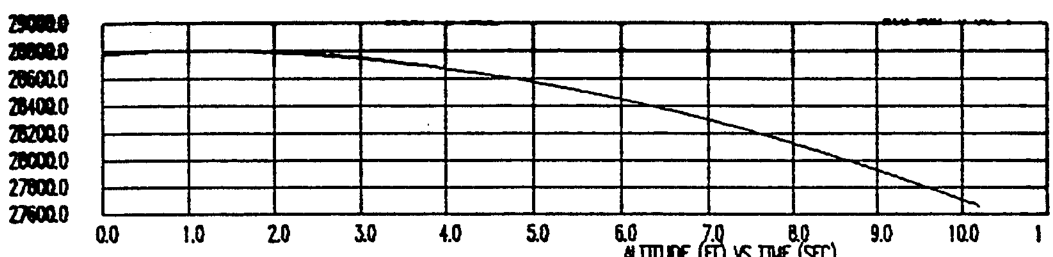
Case 7

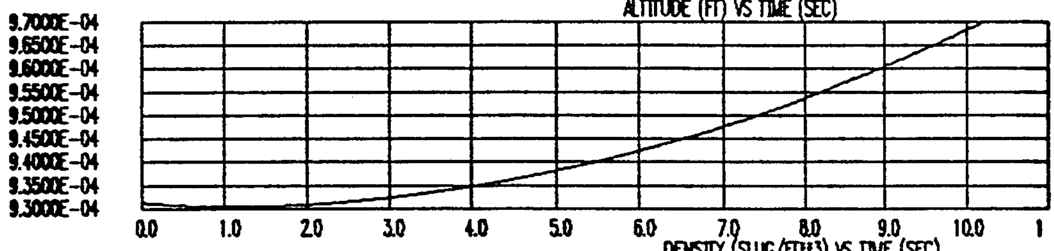

0.0000
-1.0000
-2.0000
-3.0000
-4.0000
-5.0000
-6.0000
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
4
CREW X ACCEL (G) VS TIME (SEC)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
CREW Y ACCEL (G) VS TIME (SEC)
1.60
CREW Z ACCEL (G) VS TIME (SEC)

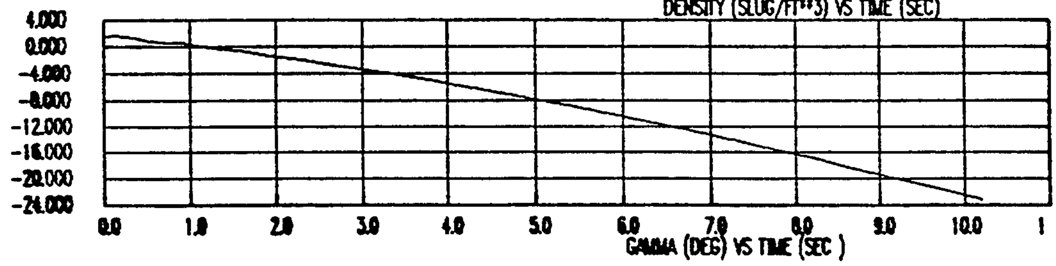
Case 8


3.0000
2.0000
1.0000
0.0000
-1.0000
-2.0000
-3.0000
-4.0000
-5.0000
-6.0000
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
ALPHA (DEG) VS TIME (SEC)

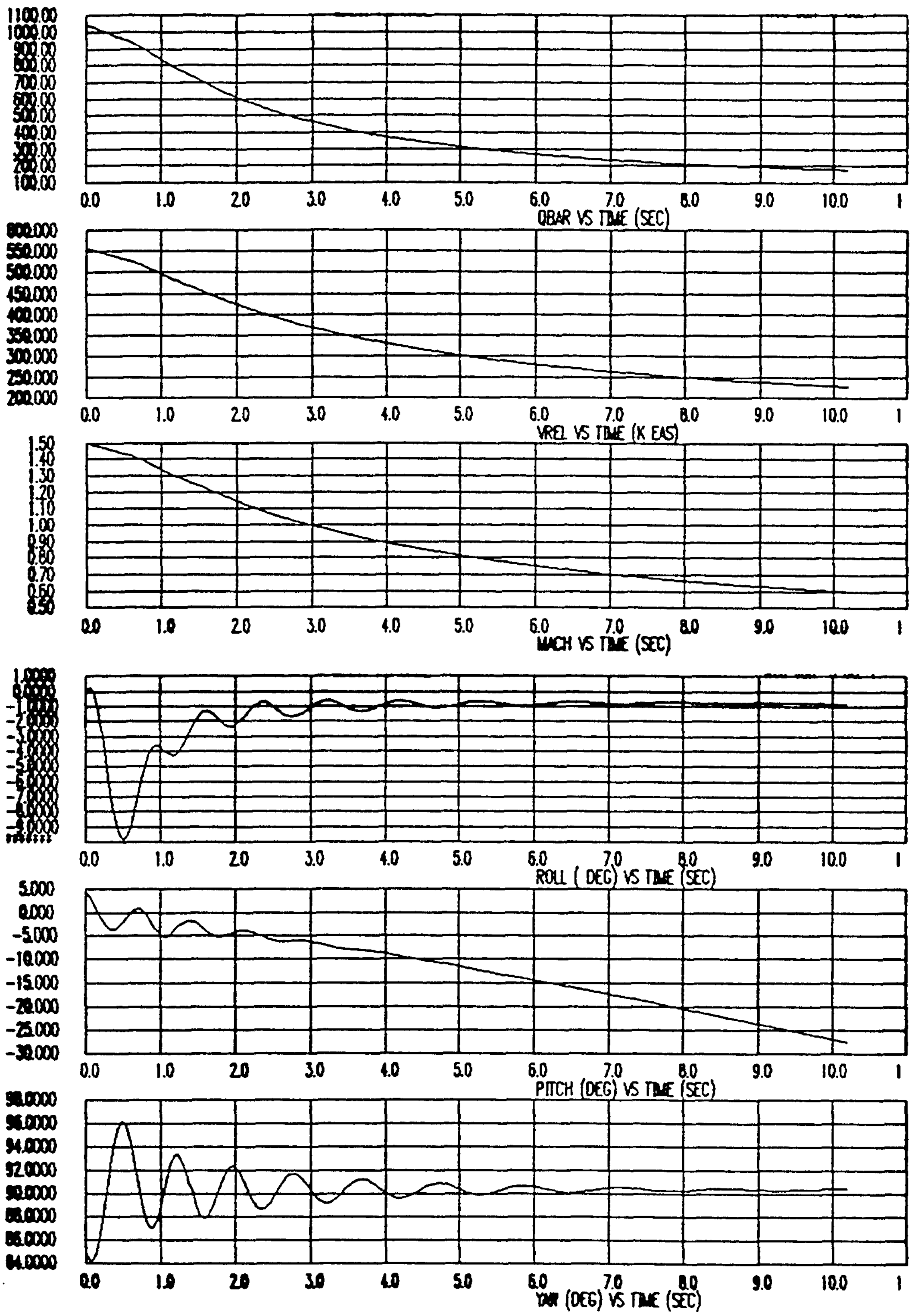

8.0000
6.0000
4.0000
2.0000
0.0000
-2.0000
-4.0000
-6.0000
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
BETA (DEG) VS TIME (SEC)

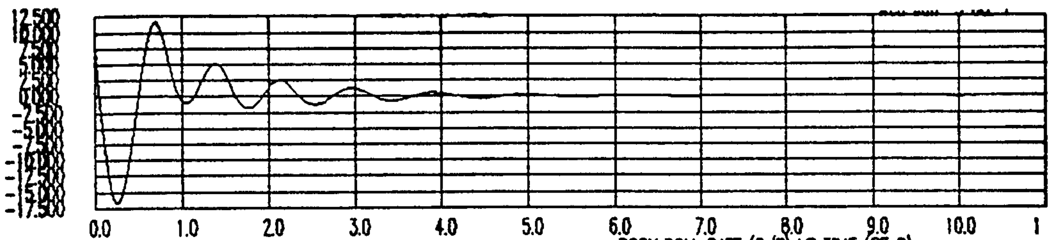

29000.0
28800.0
28600.0
28400.0
28200.0
28000.0
27800.0
27600.0
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
ALTITUDE (FT) VS TIME (SEC)


9.7000E-04
9.6500E-04
9.6000E-04
9.5500E-04
9.5000E-04
9.4500E-04
9.4000E-04
9.3500E-04
9.3000E-04
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
DENSITY (SLUG/FT**3) VS TIME (SEC)

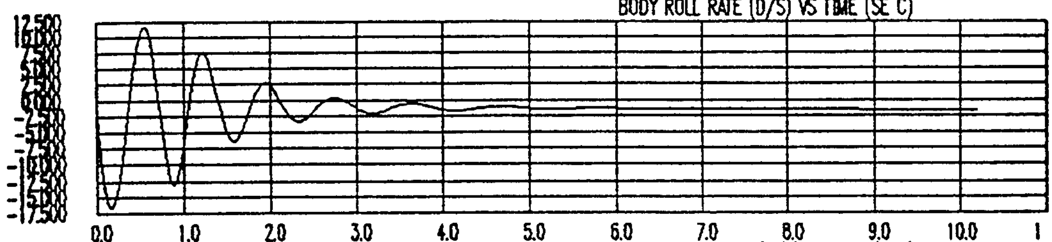

4.000
0.000
-4.000
-8.000
-12.000
-16.000
-20.000
-24.000
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
GAMMA (DEG) VS TIME (SEC)

Case 8

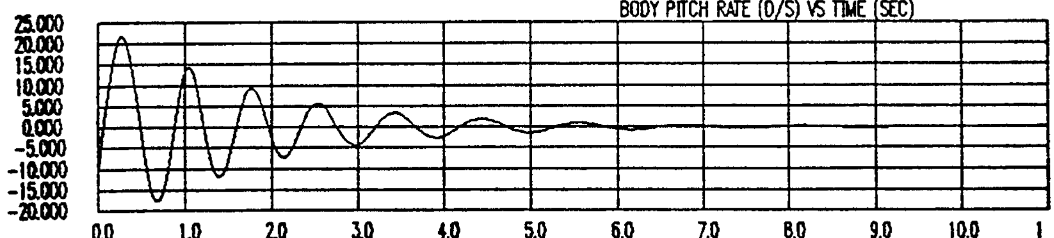

QBAR VS TIME (SEC)
VREL VS TIME (K EAS)
MACH VS TIME (SEC)
ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)



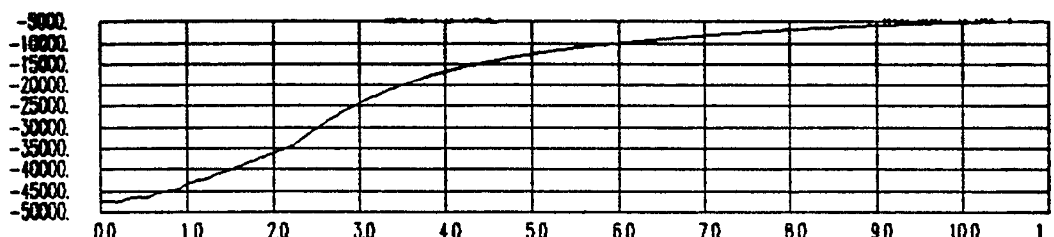
BODY ROLL RATE (D/S) VS TIME (SE C)



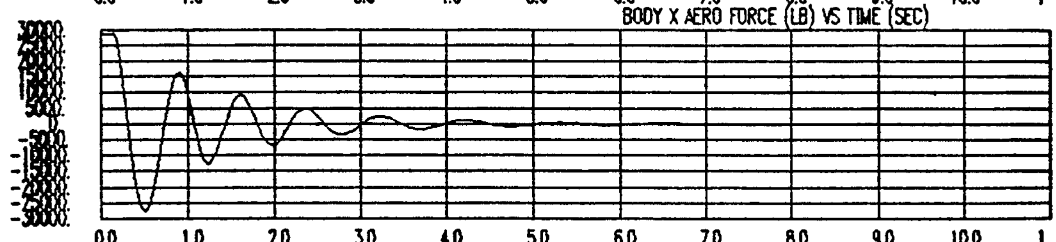
BODY PITCH RATE (D/S) VS TIME (SEC)



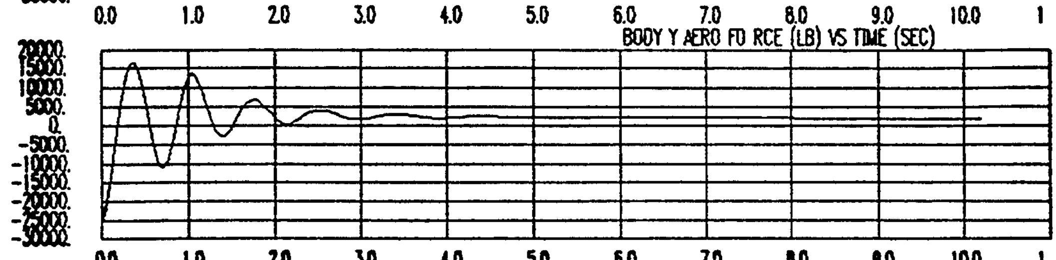
BODY YAW RATE (D/S) VS TIME (SEC)



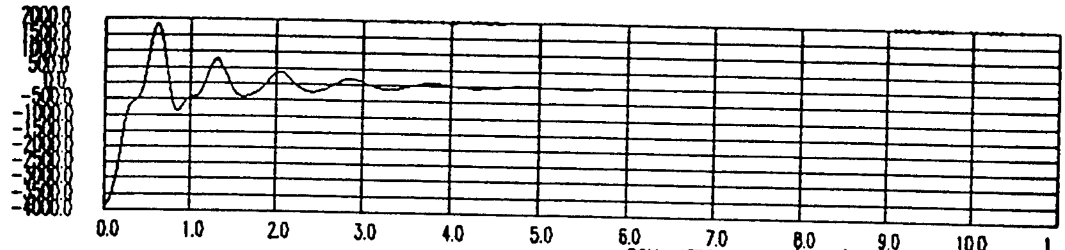
BODY X AERO FORCE (LB) VS TIME (SEC)



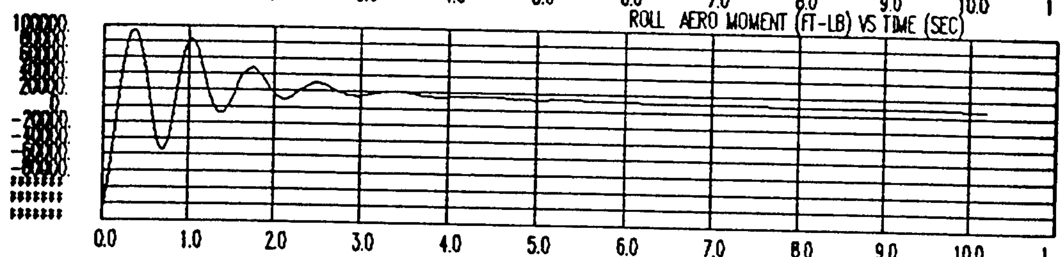
BODY Y AERO FO RCE (LB) VS TIME (SEC)



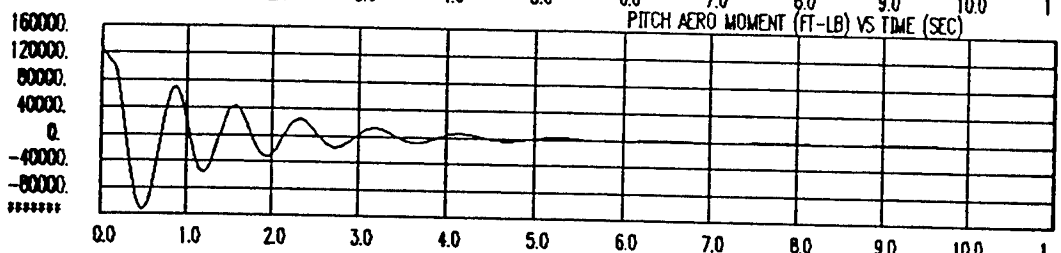
BODY Z AERO FORCE (LB) VS TIME (SEC)



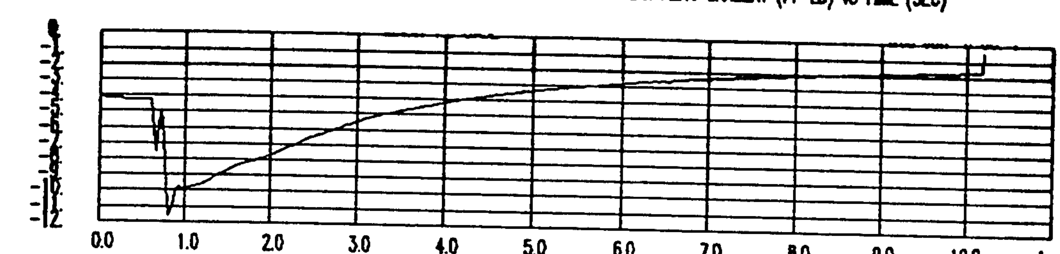
ROLL AERO MOMENT (FT-LB) VS TIME (SEC)



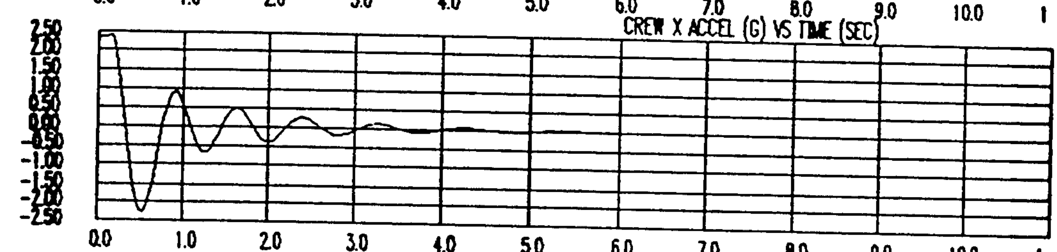
PITCH AERO MOMENT (FT-LB) VS TIME (SEC)



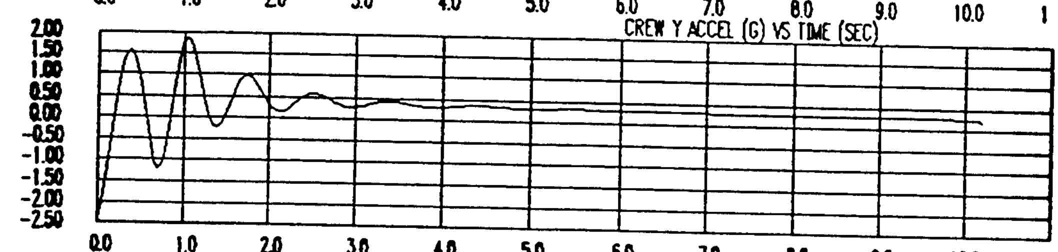
YAW AERO MOMENT (FT-LB) VS TIME (SEC)



CREW X ACCEL (G) VS TIME (SEC)

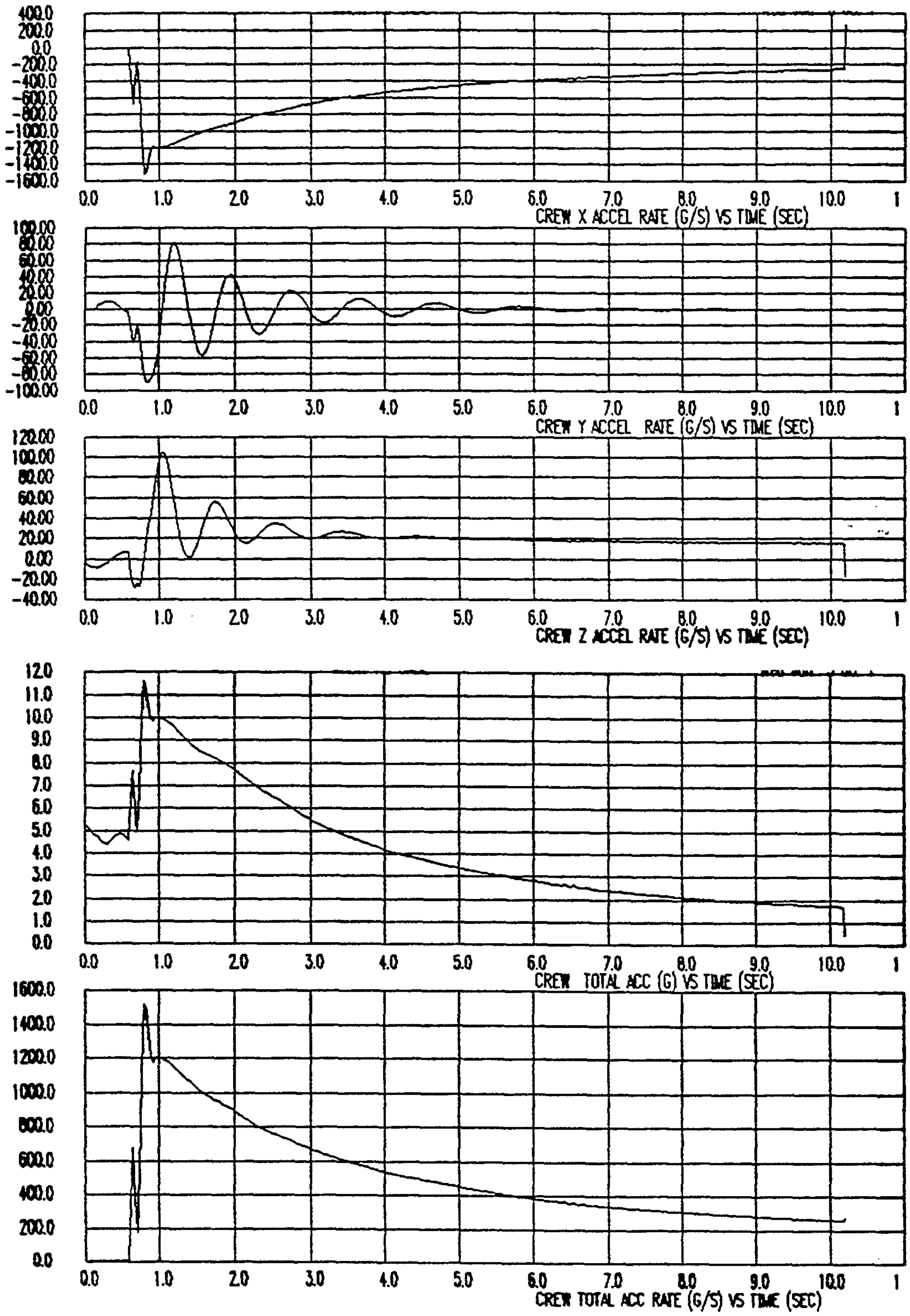


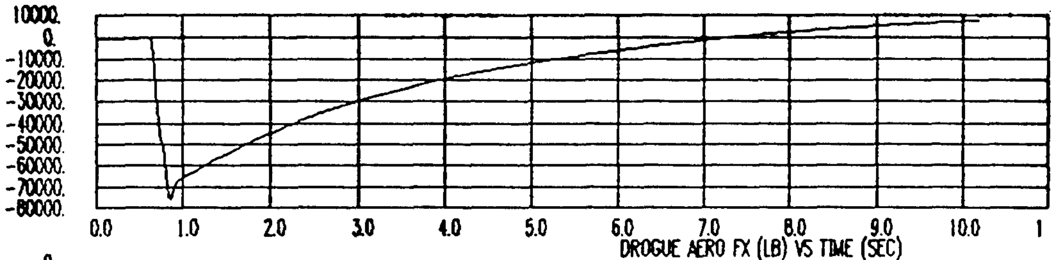
CREW Y ACCEL (G) VS TIME (SEC)



CREW Z ACCEL (G) VS TIME (SEC)

Case 8


CREW X ACCEL RATE (G/S) VS TIME (SEC)
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
CREW Z ACCEL RATE (G/S) VS TIME (SEC)
CREW TOTAL ACC (G) VS TIME (SEC)
CREW TOTAL ACC RATE (G/S) VS TIME (SEC)


10000.
0.
-10000.
-20000.
-30000.
-40000.
-50000.
-60000.
-70000.
-80000.
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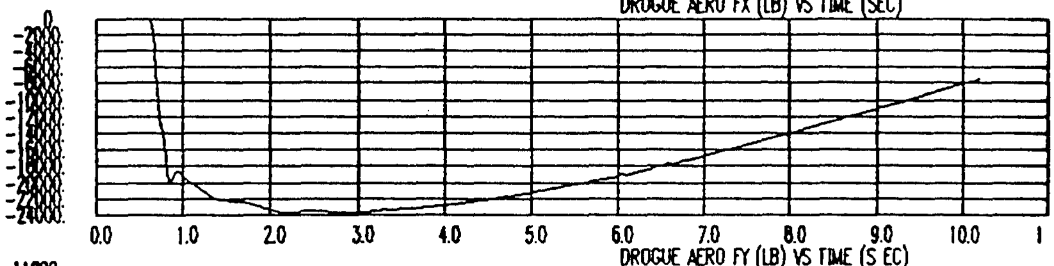
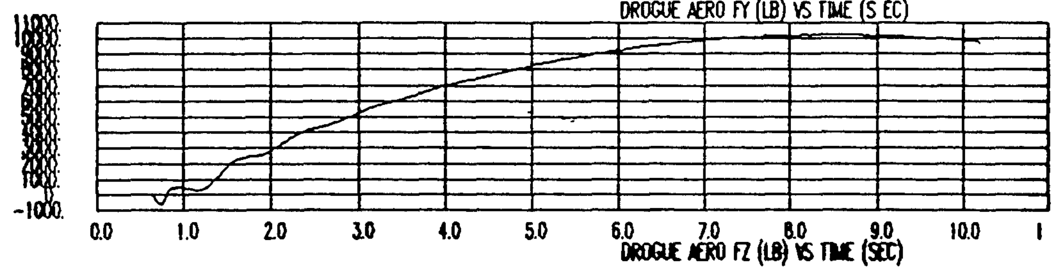
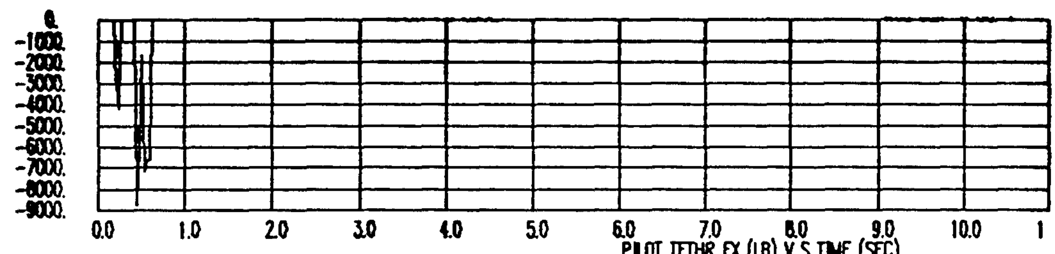
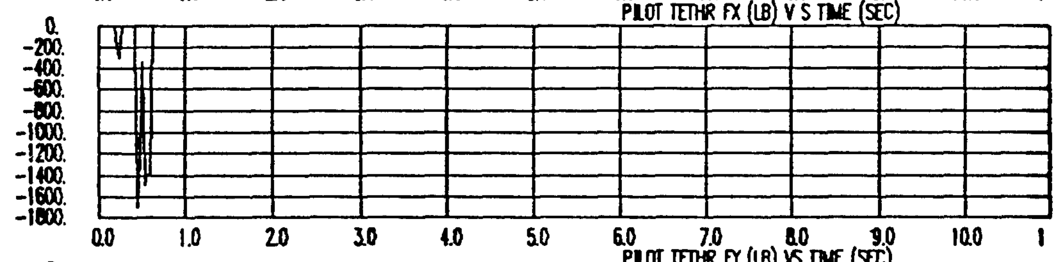
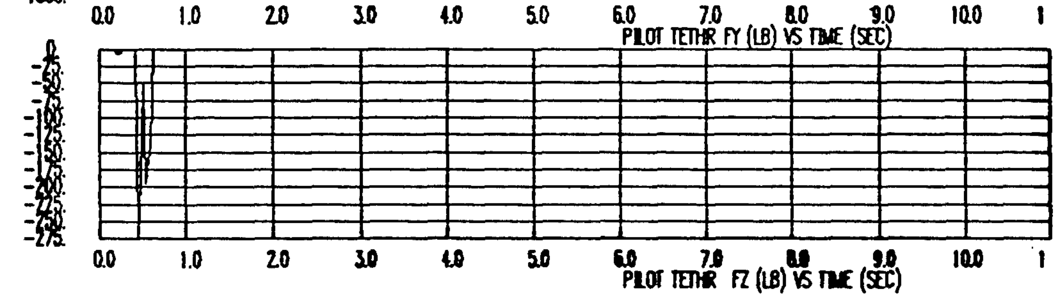
DROGUE AERO FX (LB) VS TIME (SEC)


0.
-24000.
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
DROGUE AERO FY (LB) VS TIME (S EC)

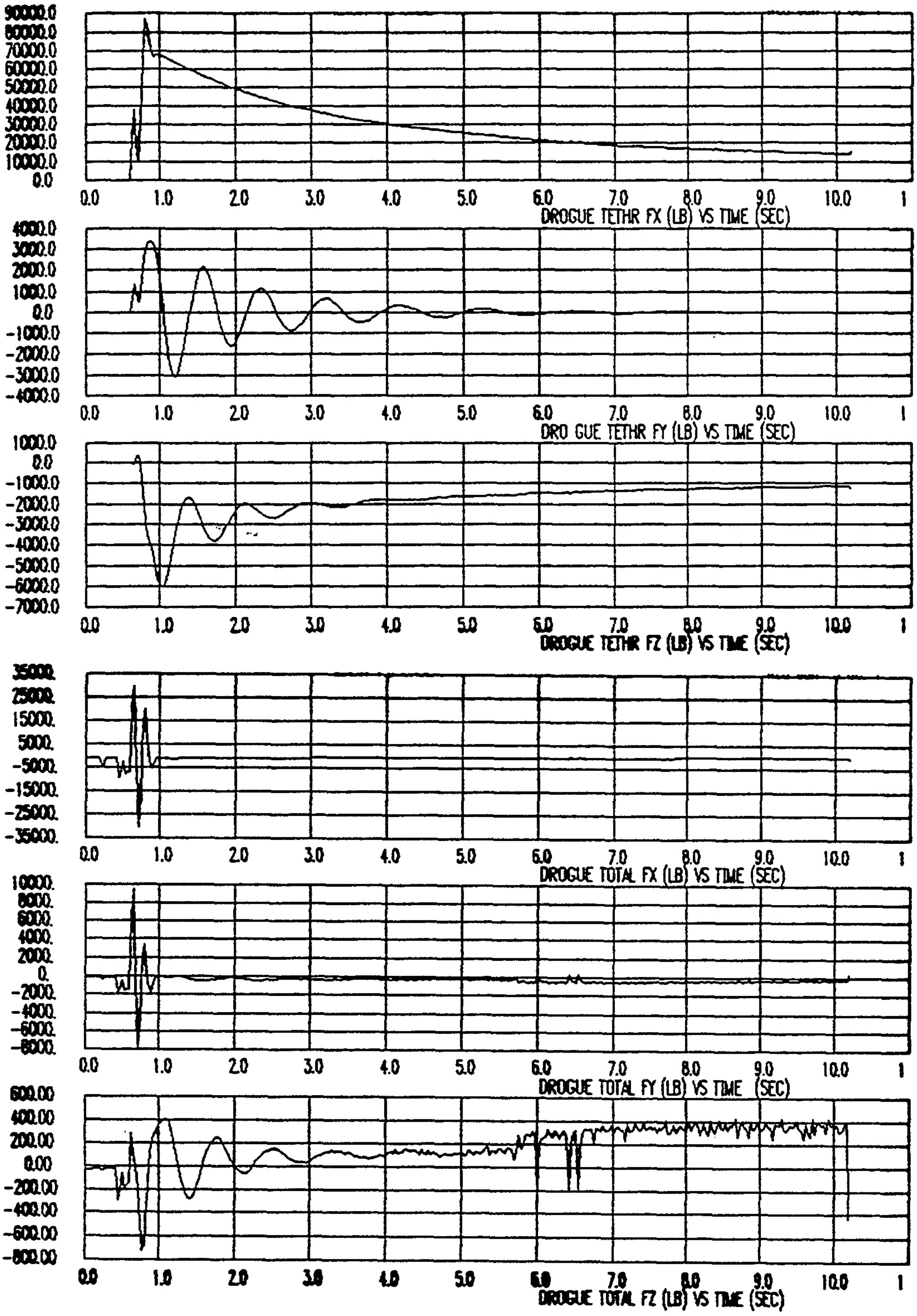

11000.
1000.
0.
-1000.
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
DROGUE AERO FZ (LB) VS TIME (SEC)

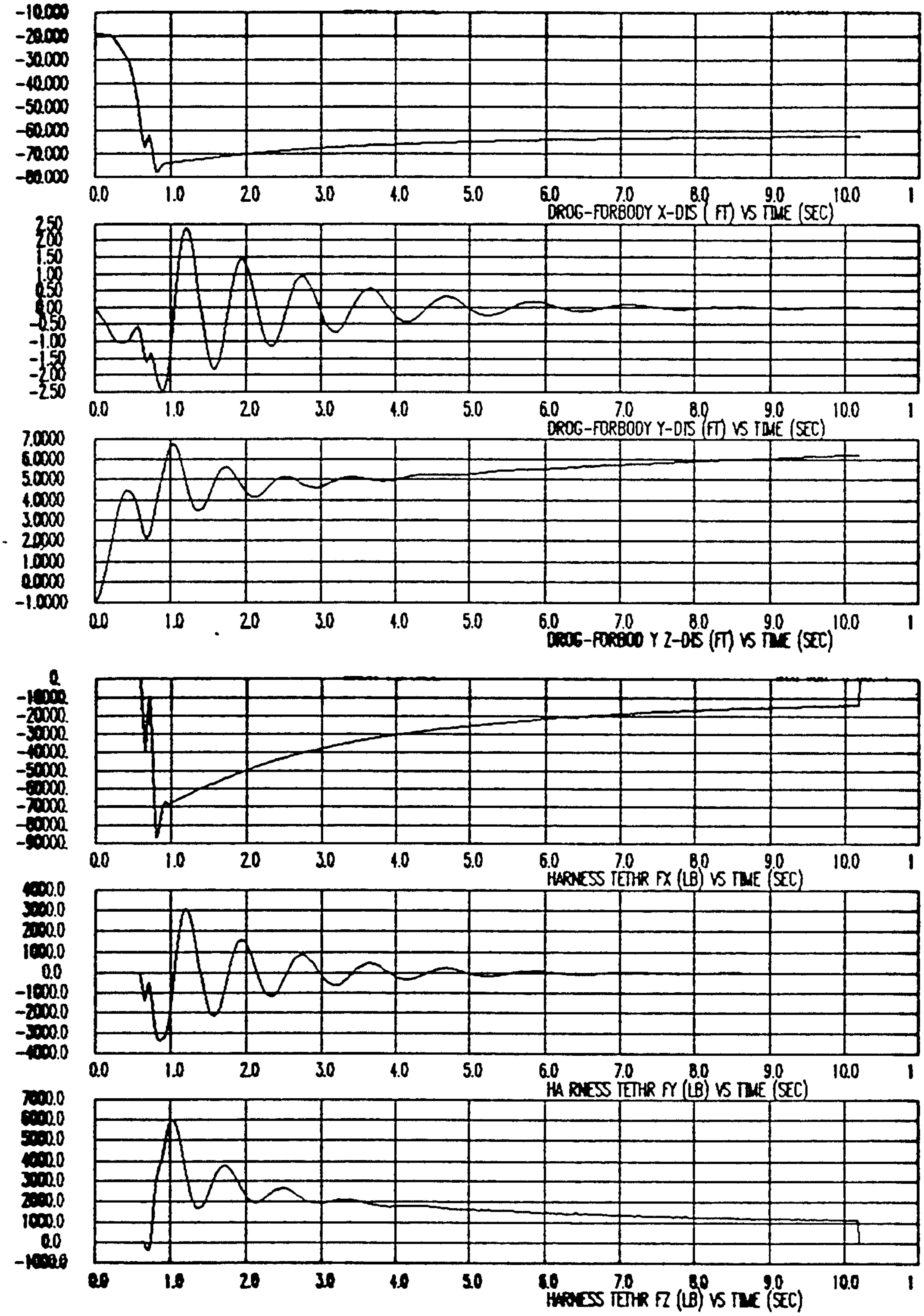

0.
-1000.
-2000.
-3000.
-4000.
-5000.
-6000.
-7000.
-8000.
-9000.
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
PILOT TETHR FX (LB) V S TIME (SEC)


0.
-200.
-400.
-600.
-800.
-1000.
-1200.
-1400.
-1600.
-1800.
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
PILOT TETHR FY (LB) VS TIME (SEC)

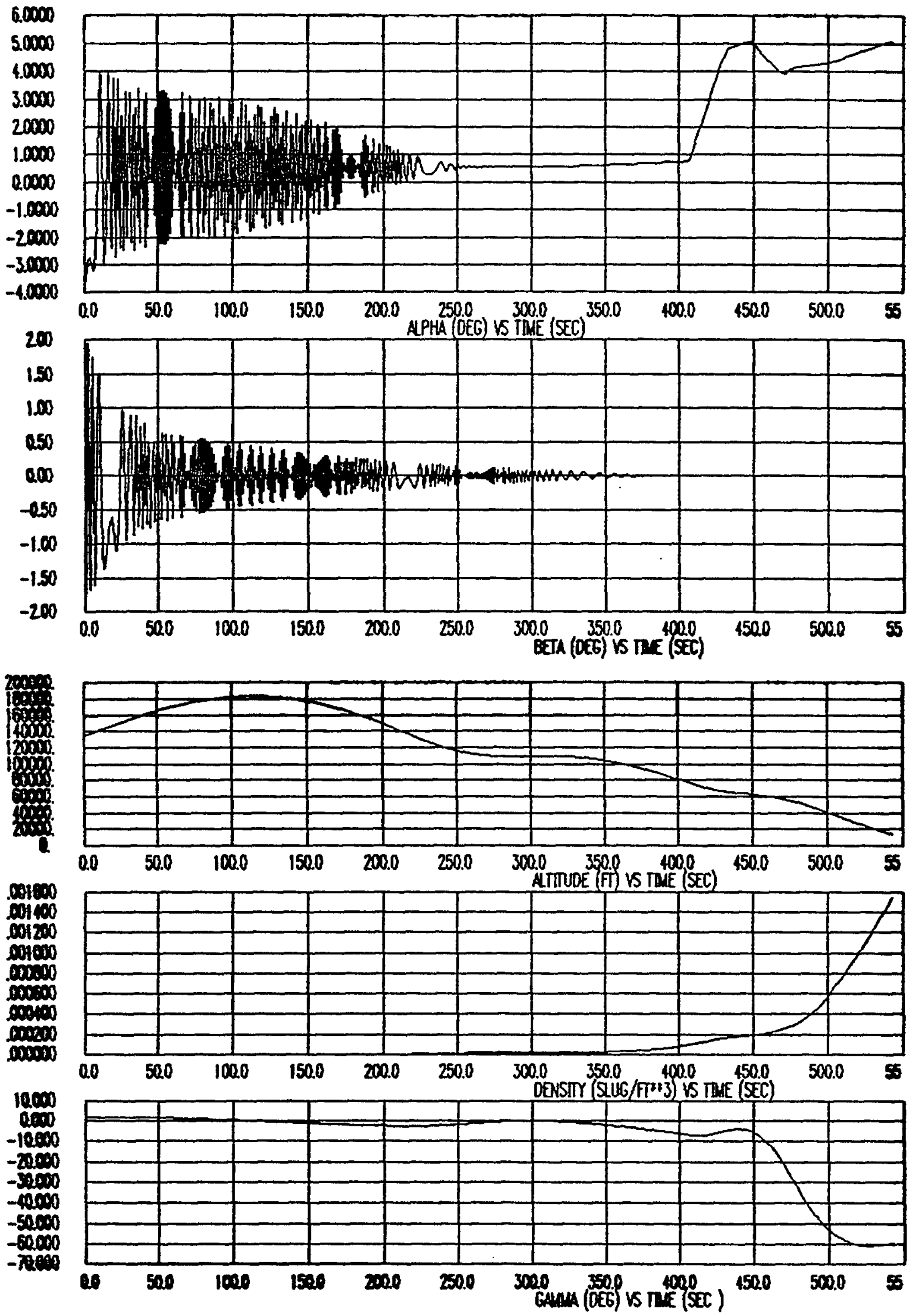

0.
-25.
-50.
-75.
-100.
-125.
-150.
-175.
-200.
-225.
-250.
-275.
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 1
PILOT TETHR FZ (LB) VS TIME (SEC)

Case 8

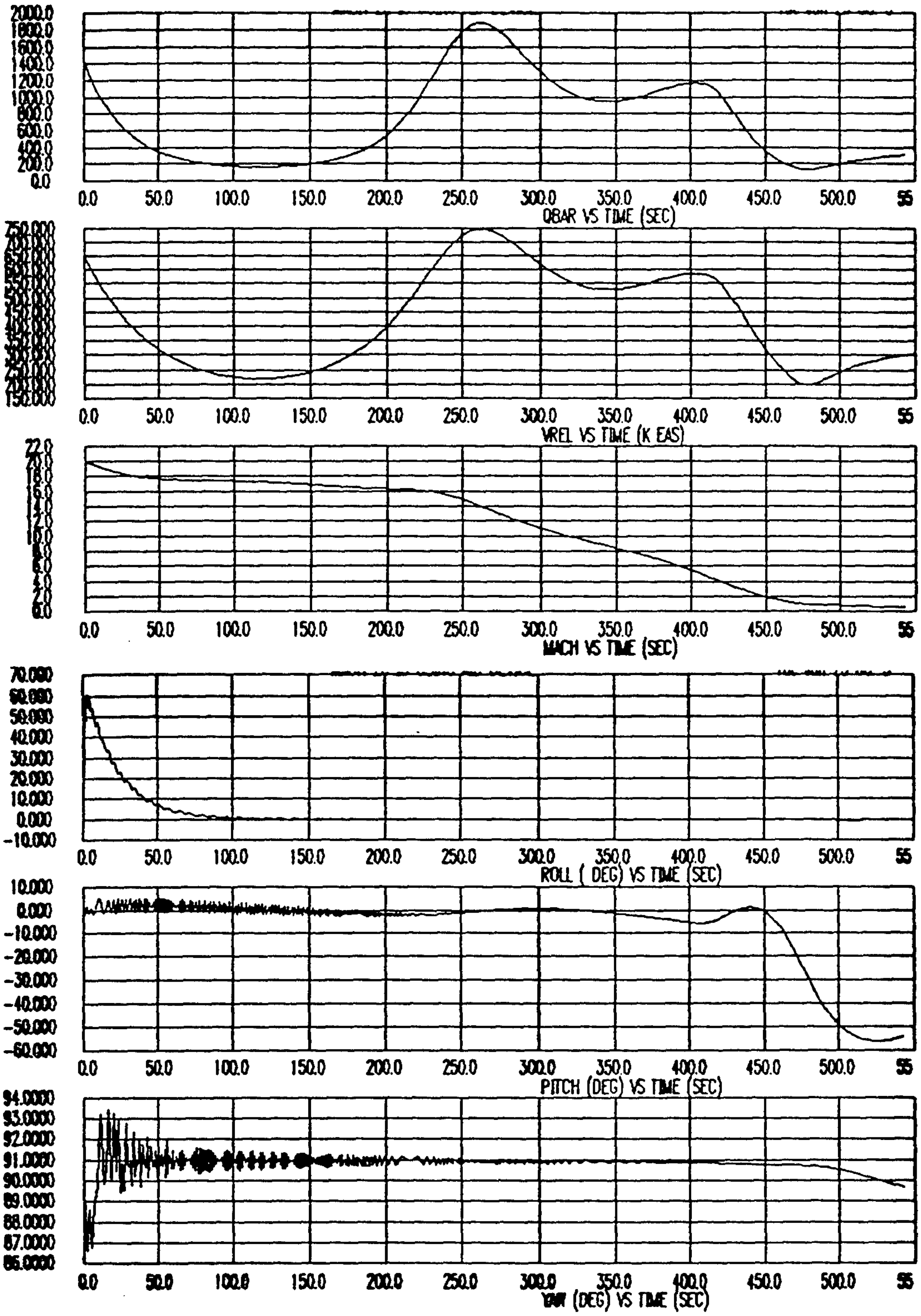

DROGUE TETHR FX (LB) VS TIME (SEC)
DRO GUE TETHR FY (LB) VS TIME (SEC)
DROGUE TETHR FZ (LB) VS TIME (SEC)
DROGUE TOTAL FX (LB) VS TIME (SEC)
DROGUE TOTAL FY (LB) VS TIME (SEC)
DROGUE TOTAL FZ (LB) VS TIME (SEC)

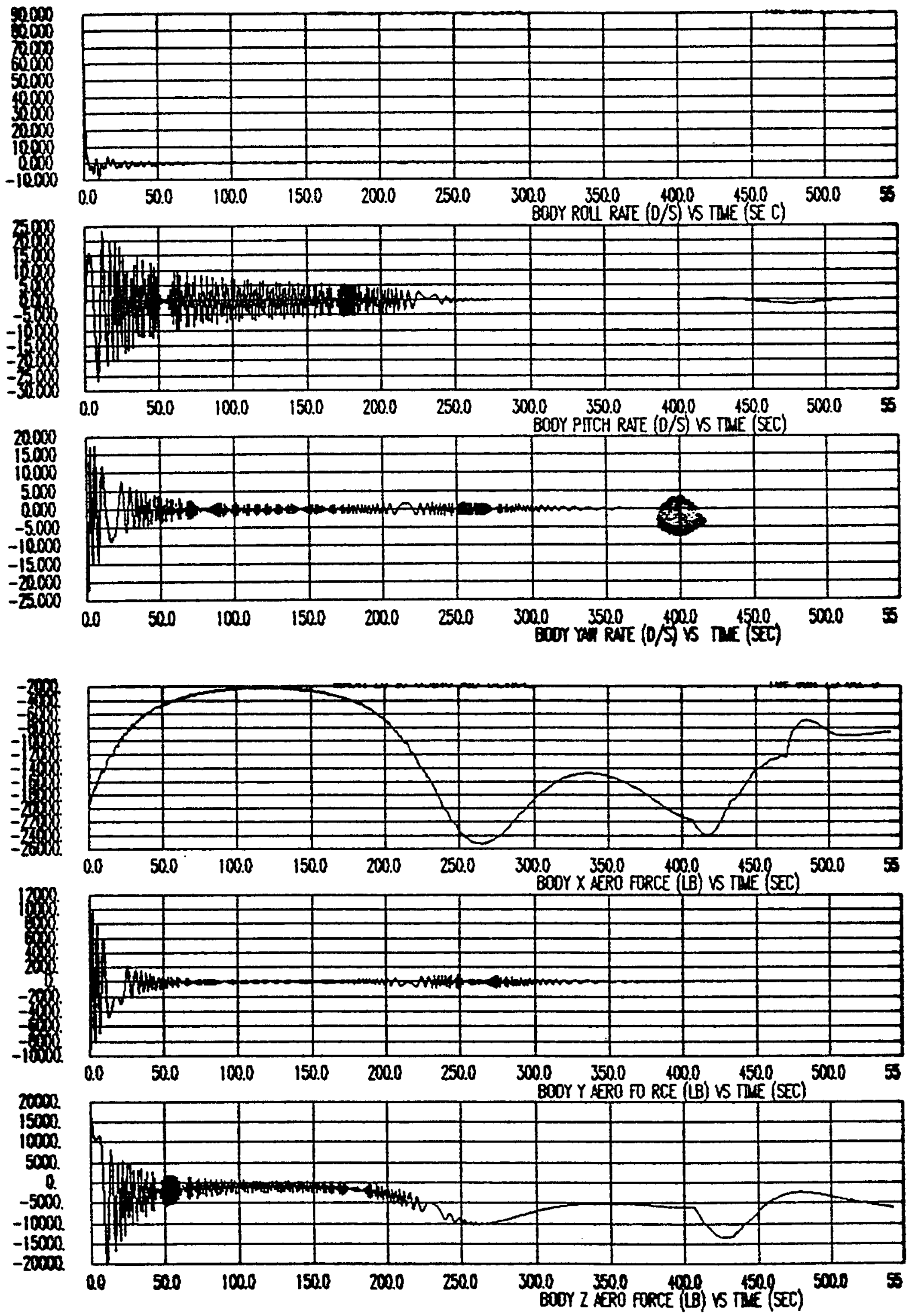

DROG-FORBODY X-DIS (FT) VS TIME (SEC)
DROG-FORBODY Y-DIS (FT) VS TIME (SEC)
DROG-FORBOD Y Z-DIS (FT) VS TIME (SEC)
HARNESS TETHR FX (LB) VS TIME (SEC)
HA RNESS TETHR FY (LB) VS TIME (SEC)
HARNESS TETHR FZ (LB) VS TIME (SEC)

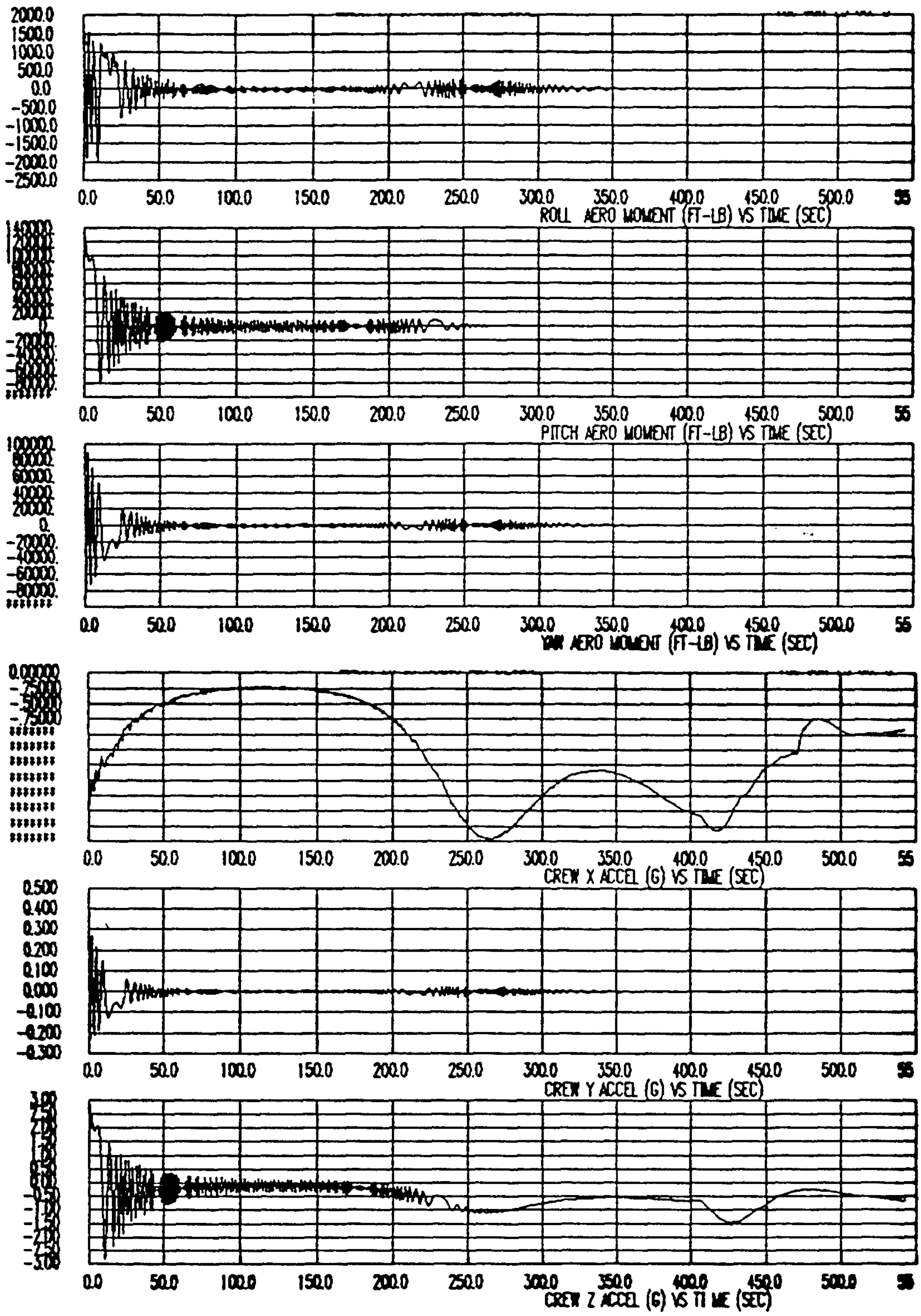
Case 9

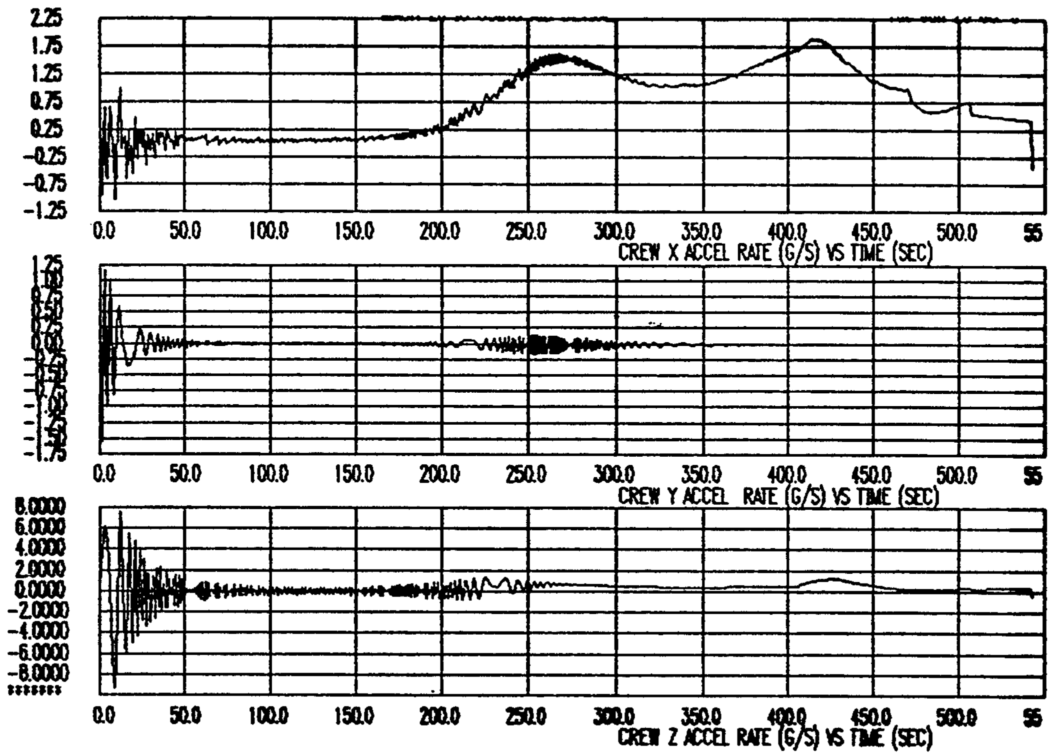


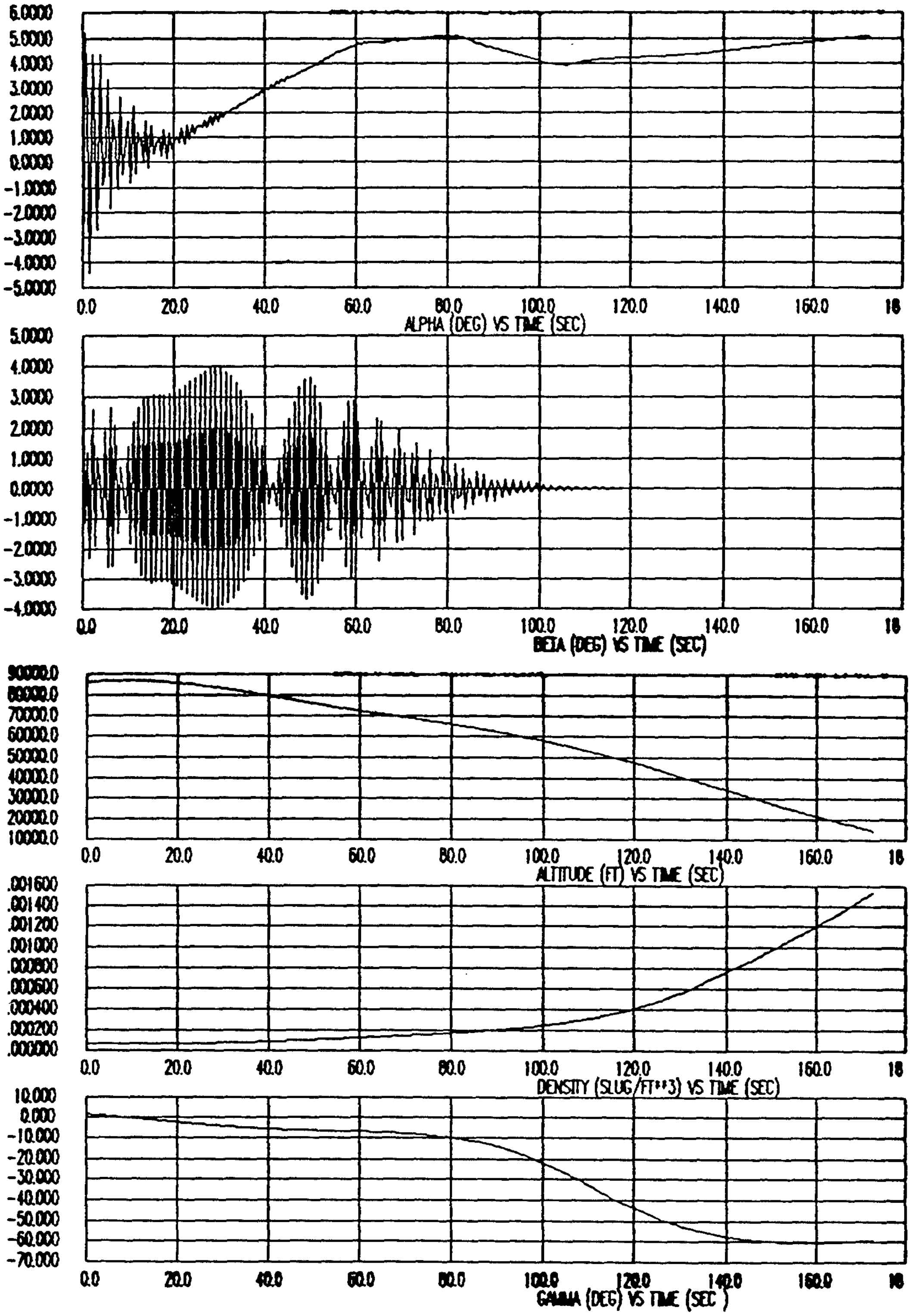
ALPHA (DEG) VS TIME (SEC)
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)


QBAR VS TIME (SEC)
VREL VS TIME (K EAS)
MACH VS TIME (SEC)
ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)

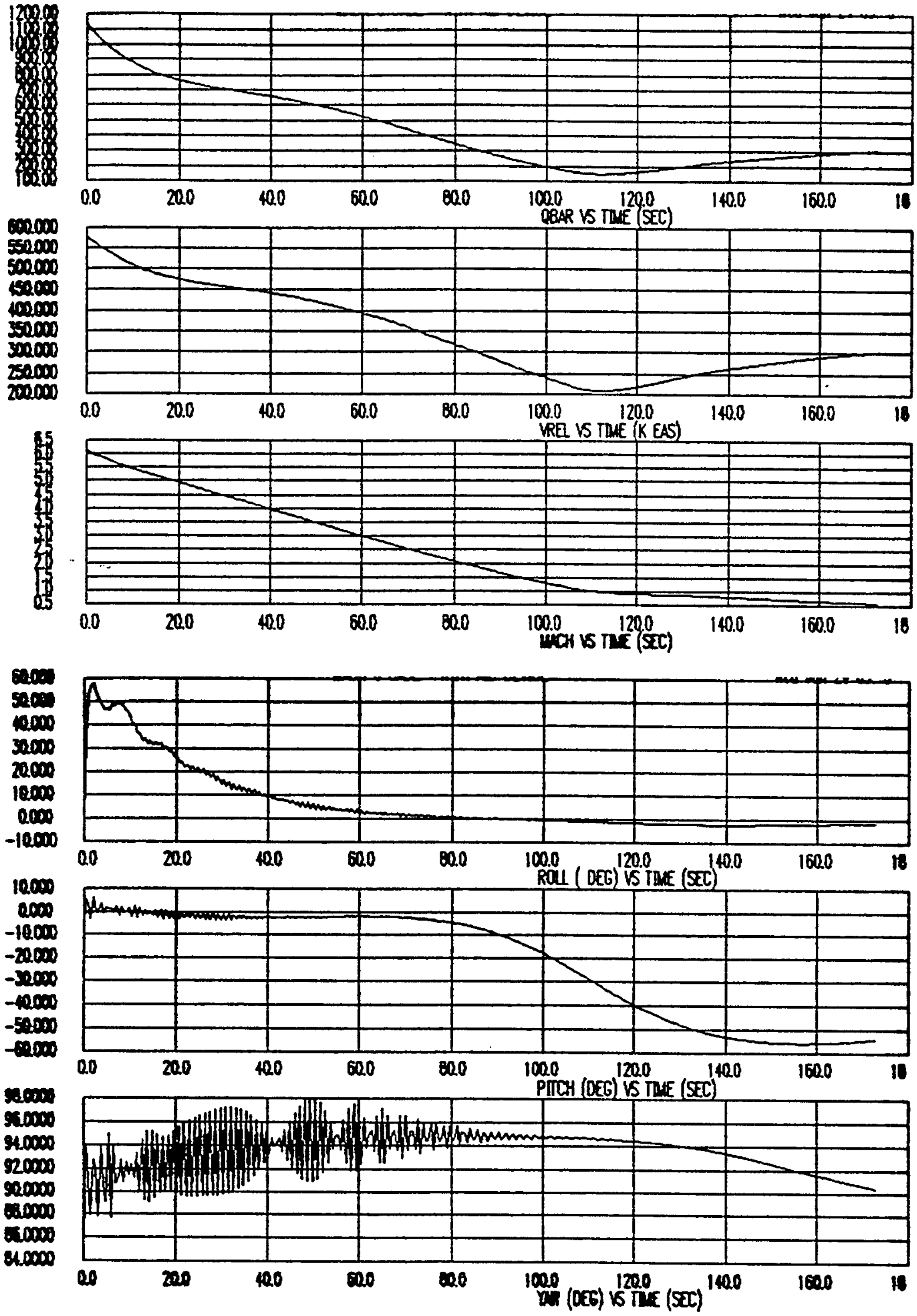

BODY ROLL RATE (D/S) VS TIME (SE C)
BODY PITCH RATE (D/S) VS TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)
BODY X AERO FORCE (LB) VS TIME (SEC)
BODY Y AERO FO RCE (LB) VS TIME (SEC)
BODY Z AERO FORCE (LB) VS TIME (SEC)

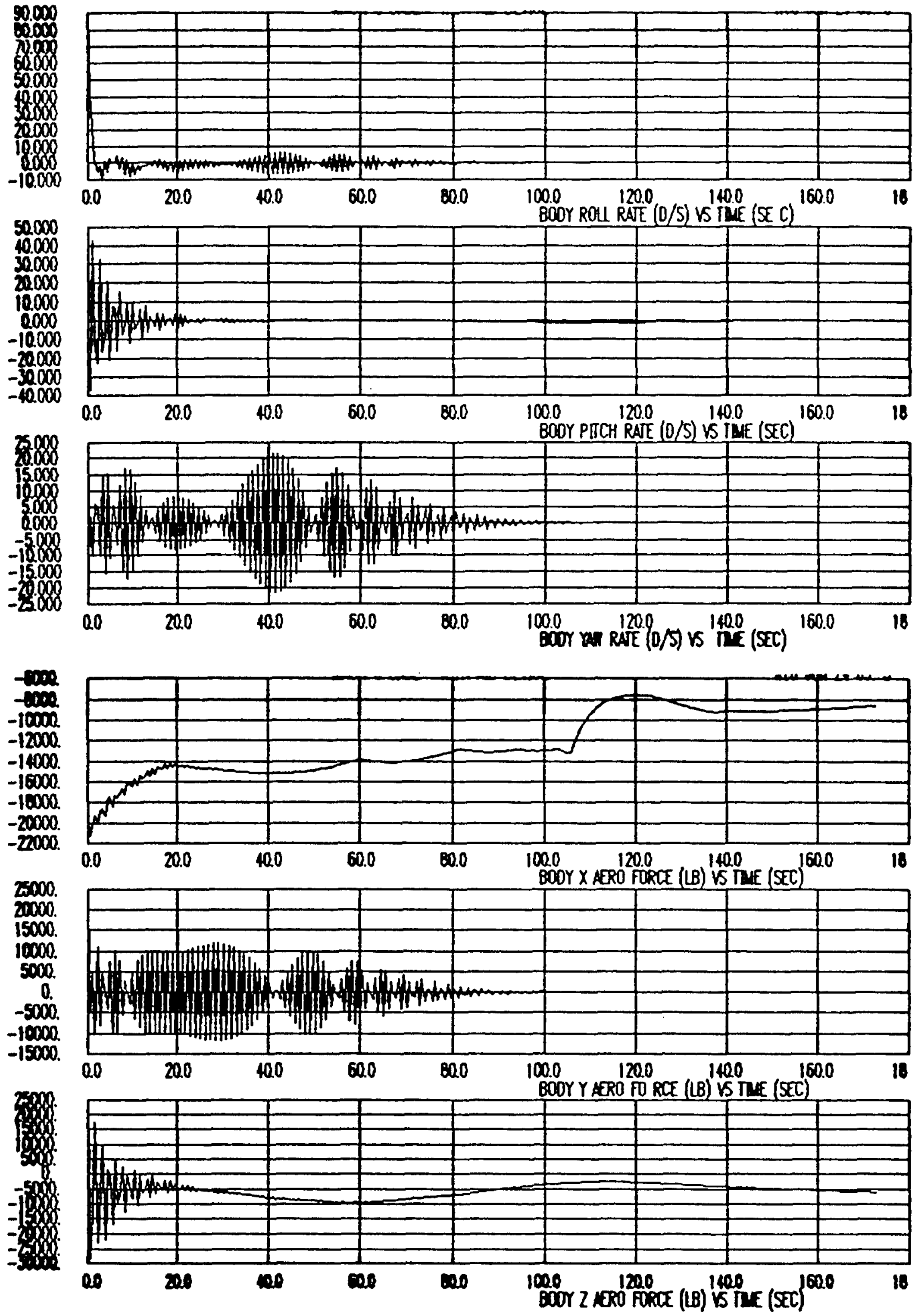

ROLL AERO MOMENT (FT-LB) VS TIME (SEC)
PITCH AERO MOMENT (FT-LB) VS TIME (SEC)
YAW AERO MOMENT (FT-LB) VS TIME (SEC)
CREW X ACCEL (G) VS TIME (SEC)
CREW Y ACCEL (G) VS TIME (SEC)
CREW Z ACCEL (G) VS TIME (SEC)

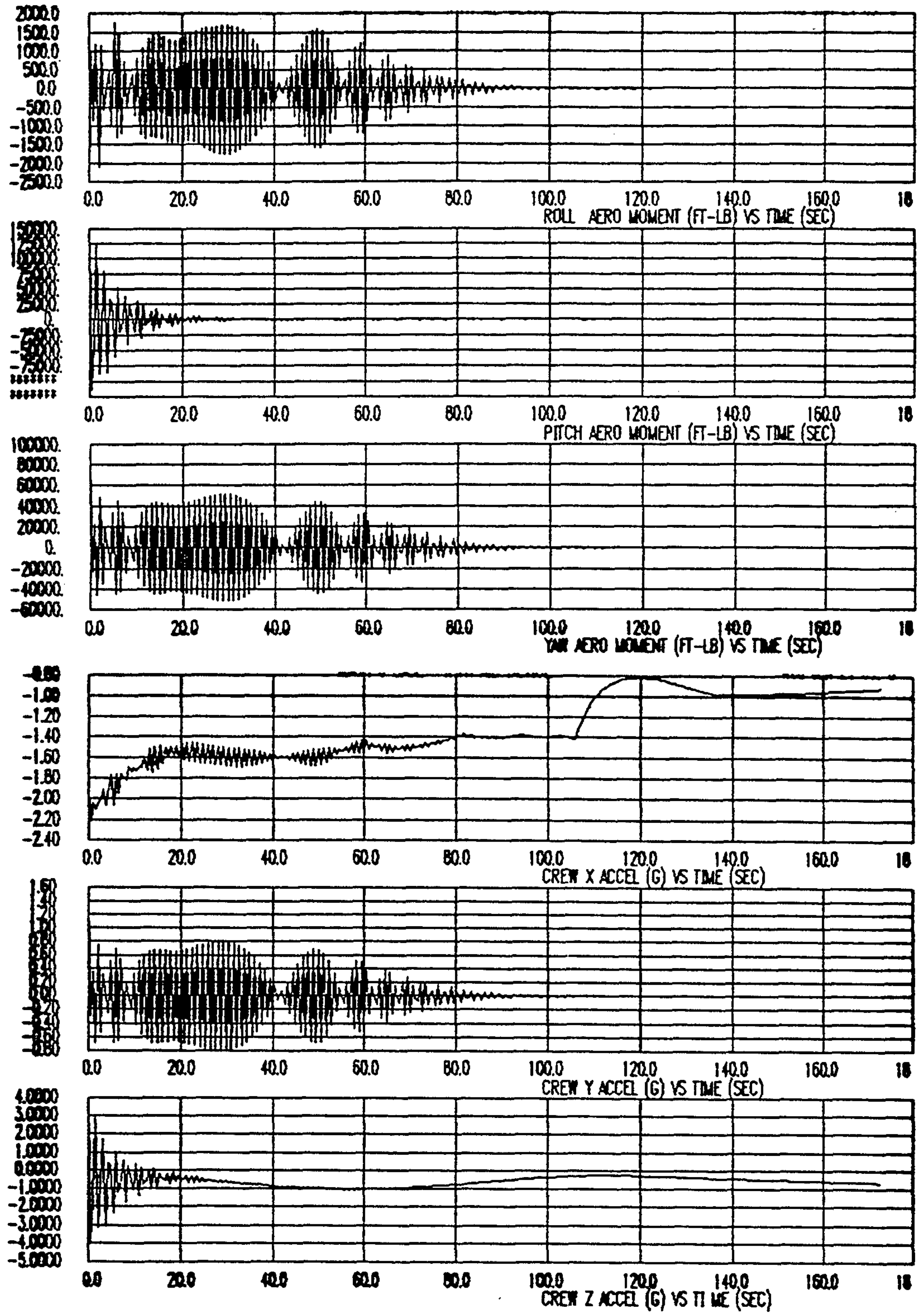

CREW X ACCEL RATE (G/S) VS TIME (SEC)
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
CREW Z ACCEL RATE (G/S) VS TIME (SEC)

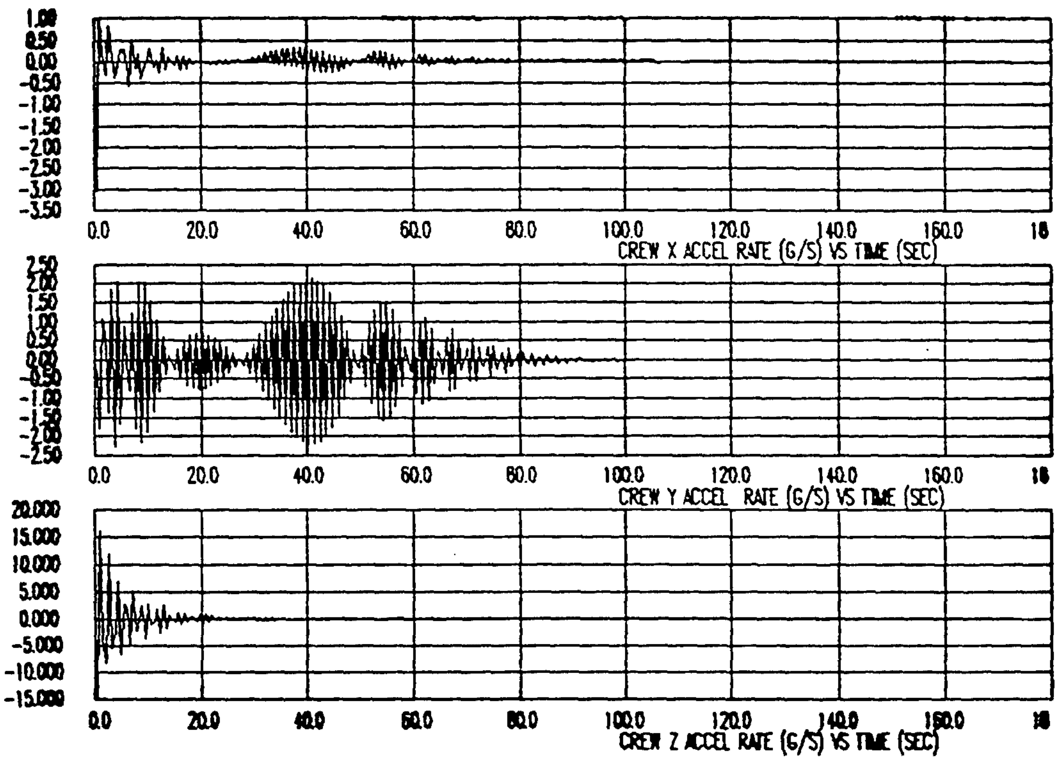

ALPHA (DEG) VS TIME (SEC)
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)

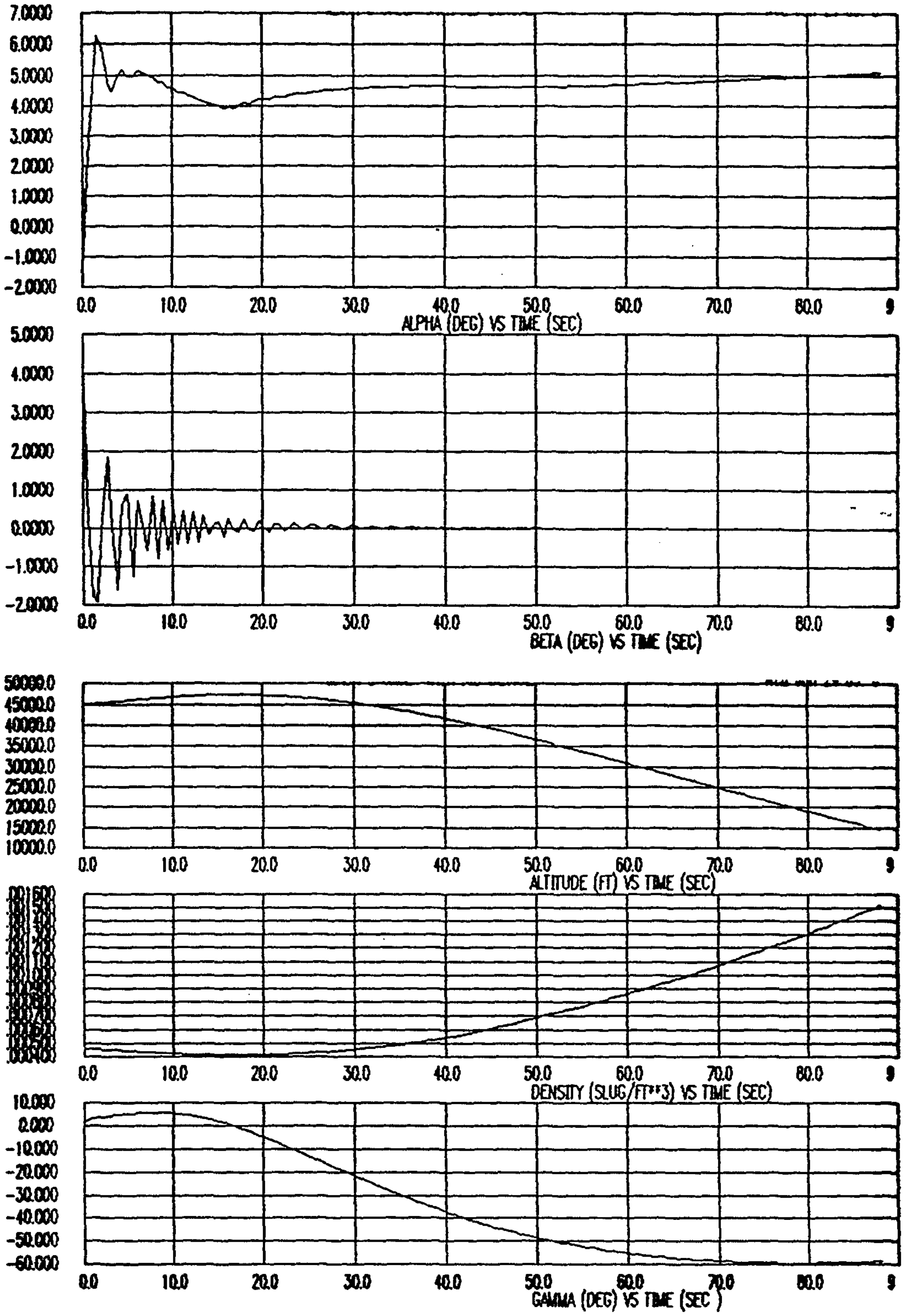
Case 10

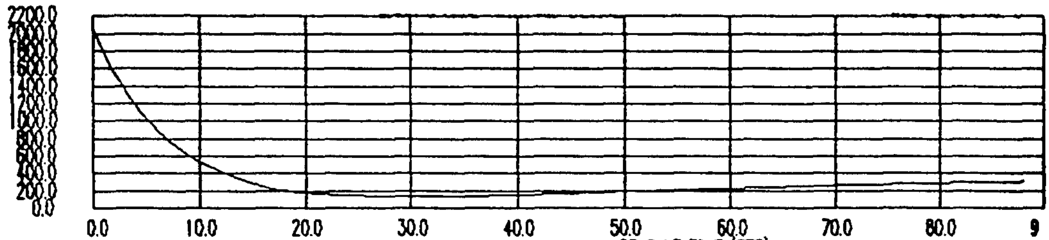

QBAR VS TIME (SEC)
VREL VS TIME (K EAS)
MACH VS TIME (SEC)
ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)


BODY ROLL RATE (D/S) VS TIME (SE C)
BODY PITCH RATE (D/S) VS TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)
BODY X AERO FORCE (LB) VS TIME (SEC)
BODY Y AERO FO RCE (LB) VS TIME (SEC)
BODY Z AERO FORCE (LB) VS TIME (SEC)

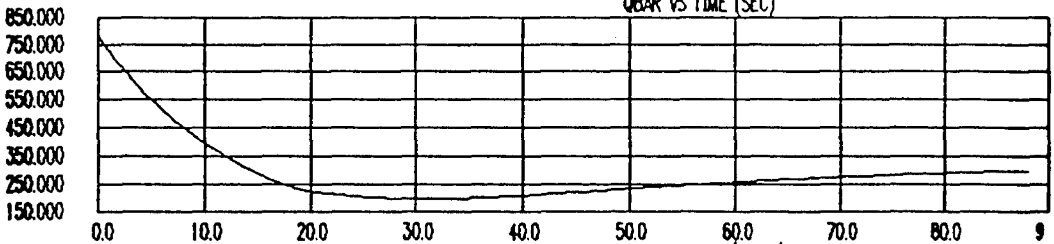

ROLL AERO MOMENT (FT-LB) VS TIME (SEC)
PITCH AERO MOMENT (FT-LB) VS TIME (SEC)
YAW AERO MOMENT (FT-LB) VS TIME (SEC)
CREW X ACCEL (G) VS TIME (SEC)
CREW Y ACCEL (G) VS TIME (SEC)
CREW Z ACCEL (G) VS TIME (SEC)


CREW X ACCEL RATE (G/S) VS TIME (SEC)
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
CREW Z ACCEL RATE (G/S) VS TIME (SEC)

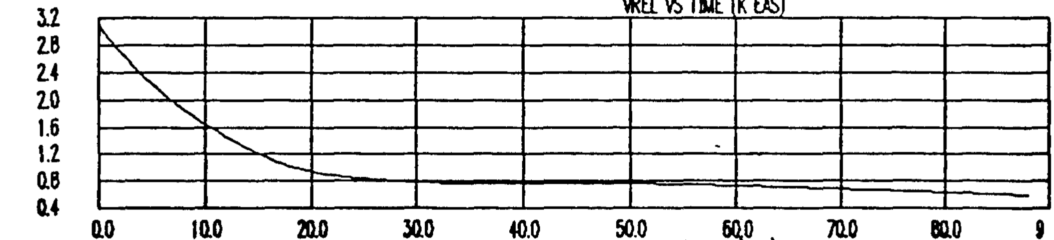

ALPHA (DEG) VS TIME (SEC)
BETA (DEG) VS TIME (SEC)
ALTITUDE (FT) VS TIME (SEC)
DENSITY (SLUG/FT**3) VS TIME (SEC)
GAMMA (DEG) VS TIME (SEC)



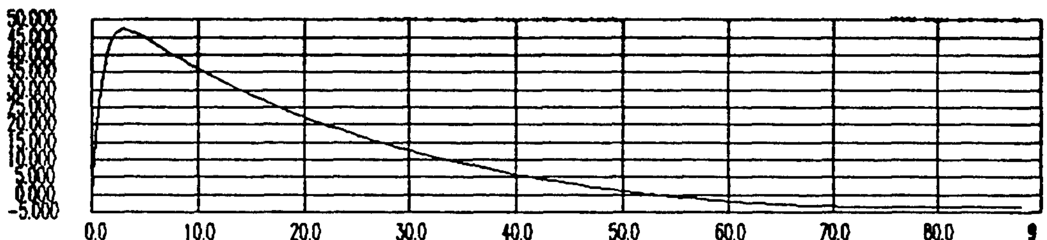
QBAR VS TIME (SEC)



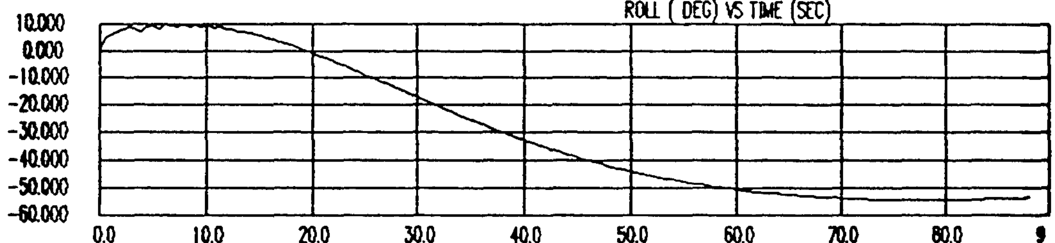
VREL VS TIME (K EAS)



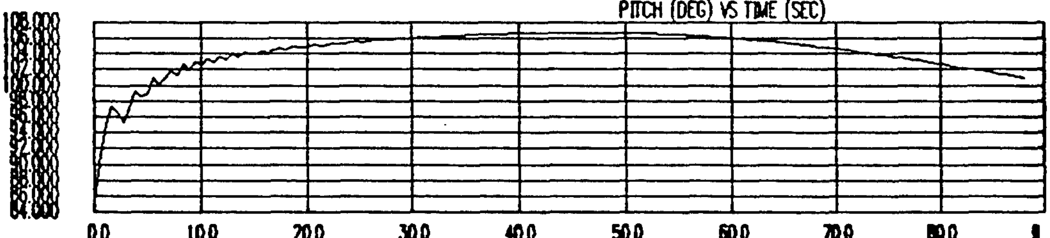
MACH VS TIME (SEC)



ROLL (DEG) VS TIME (SEC)

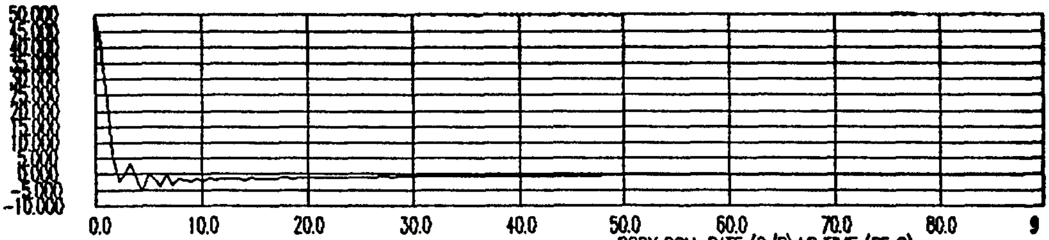


PITCH (DEG) VS TIME (SEC)

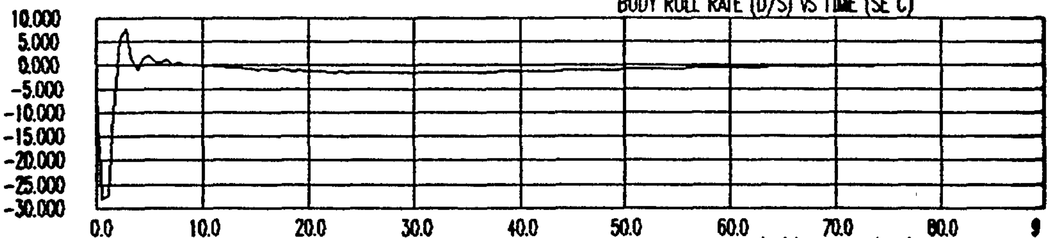


YAW (DEG) VS TIME (SEC)

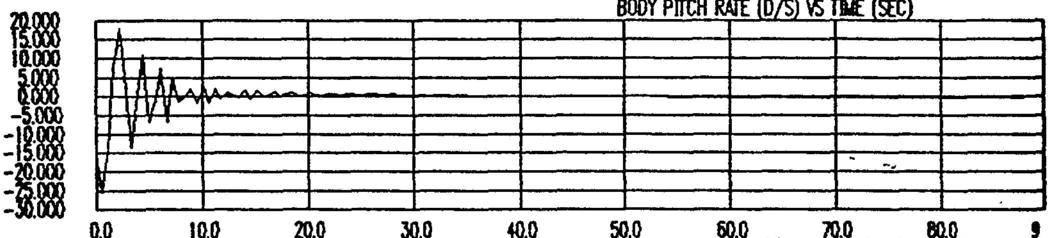
Case 11



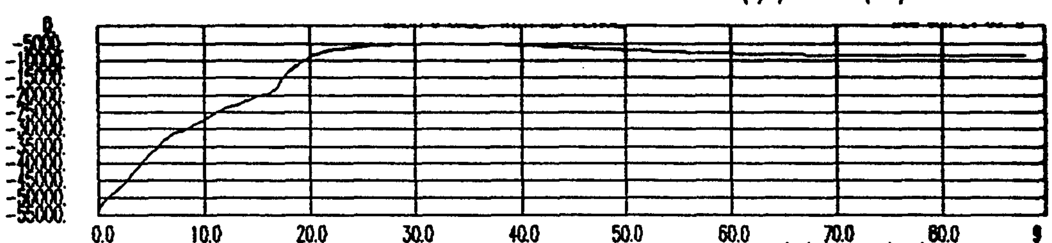
BODY ROLL RATE (D/S) VS TIME (SE C)



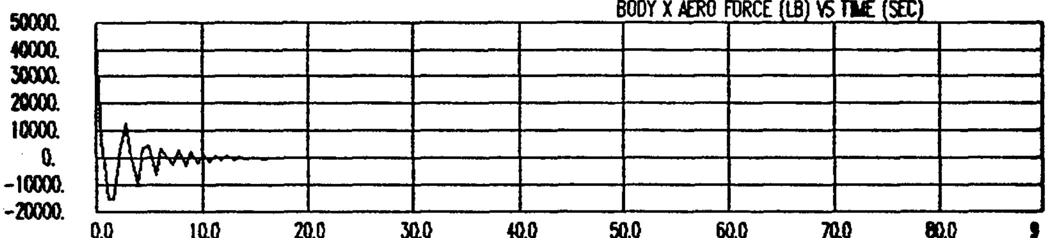
BODY PITCH RATE (D/S) VS TIME (SEC)



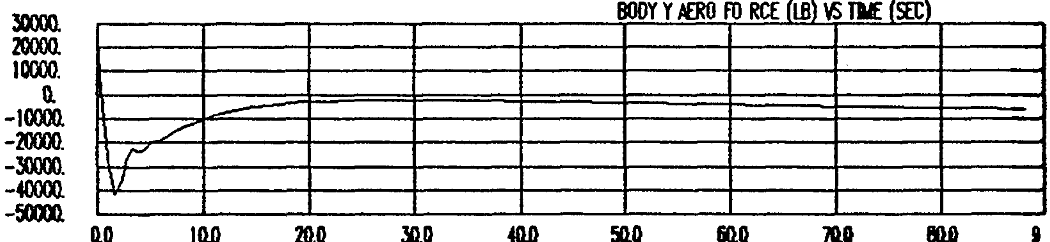
BODY YAW RATE (D/S) VS TIME (SEC)



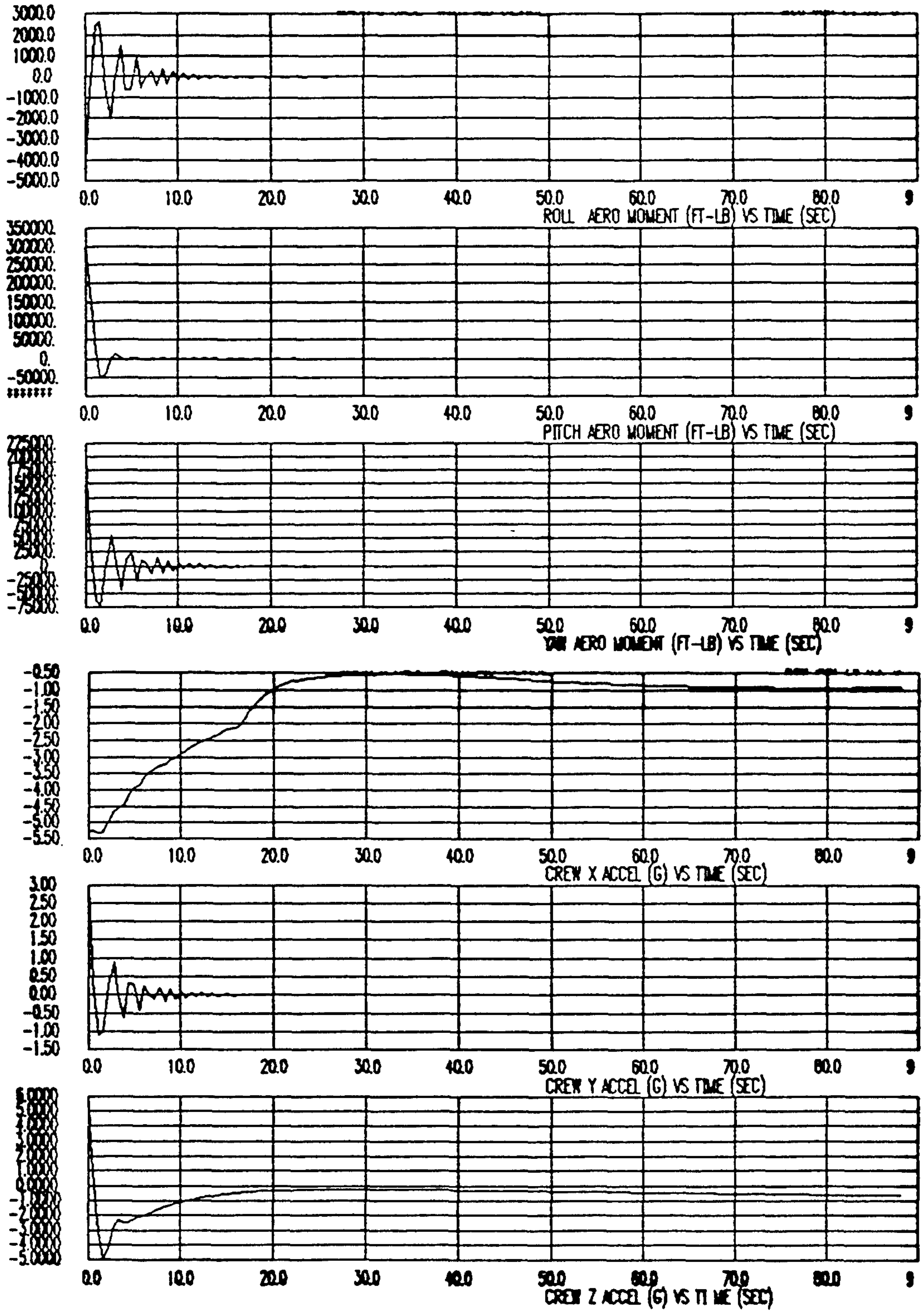
BODY X AERO FORCE (LB) VS TIME (SEC)

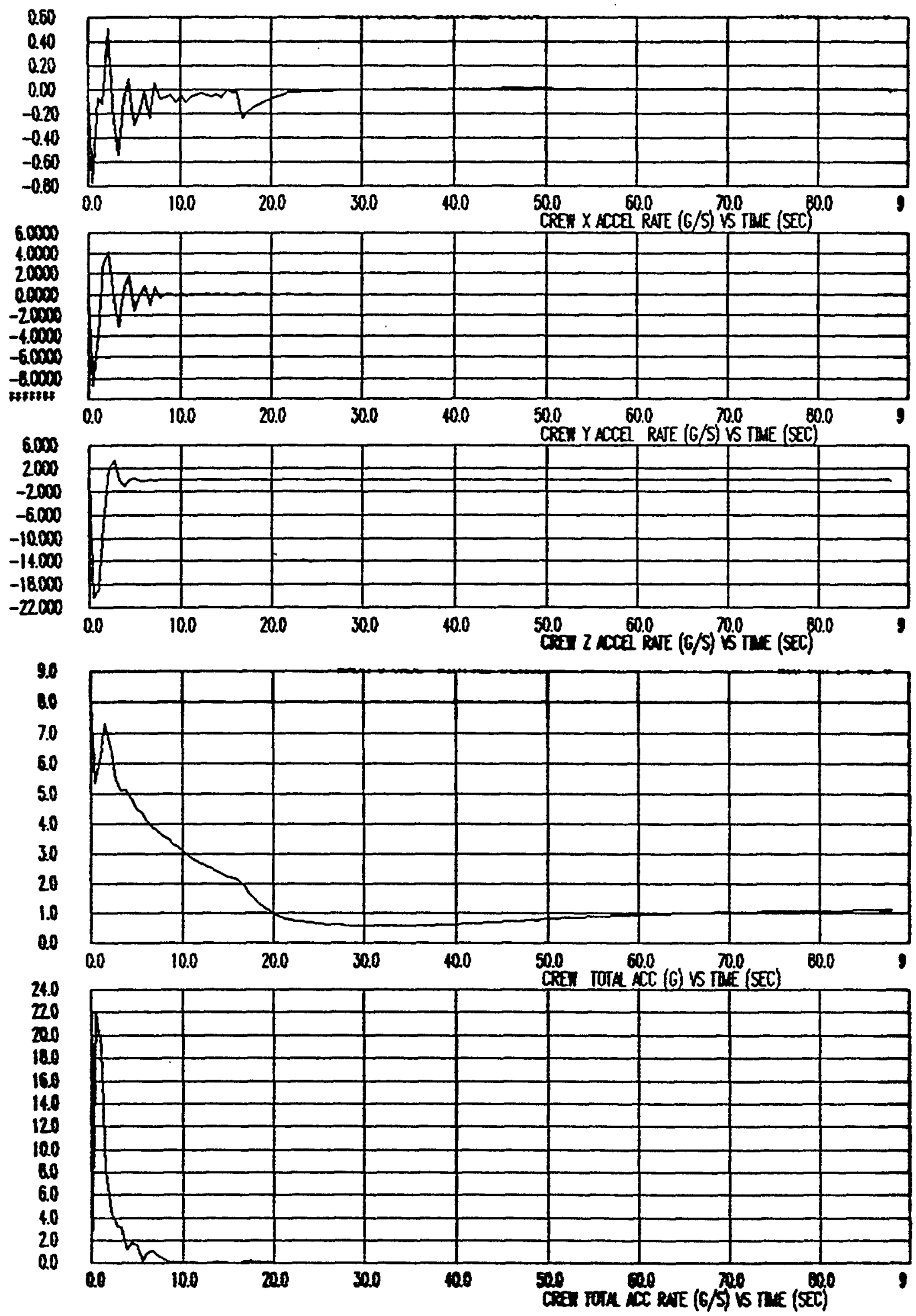


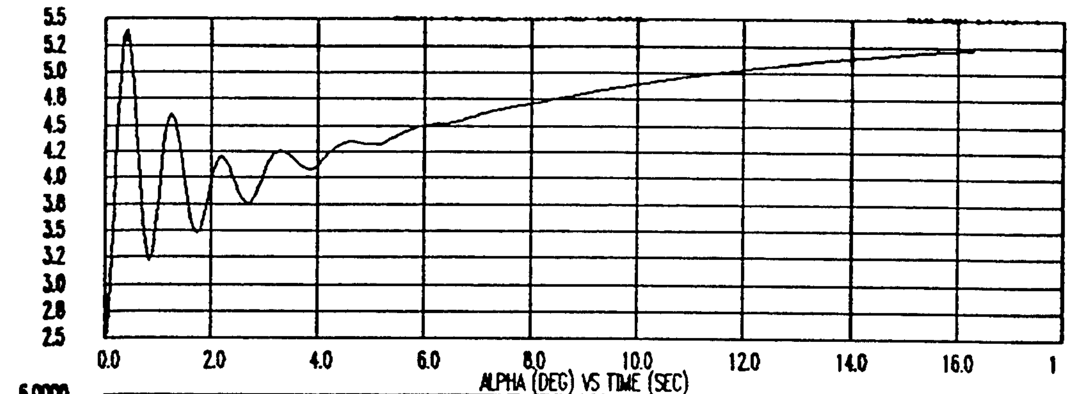
BODY Y AERO FO RCE (LB) VS TIME (SEC)

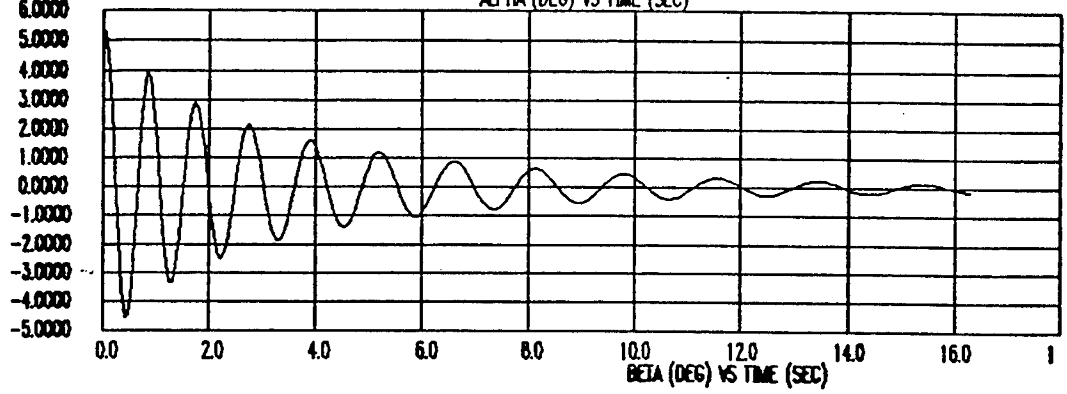


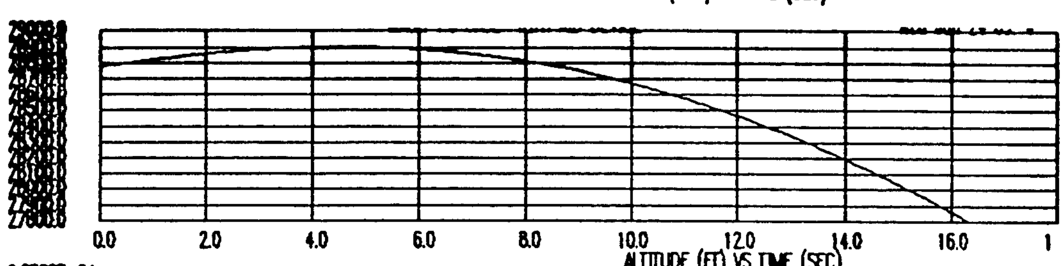
BODY Z AERO FORCE (LB) VS TIME (SEC)

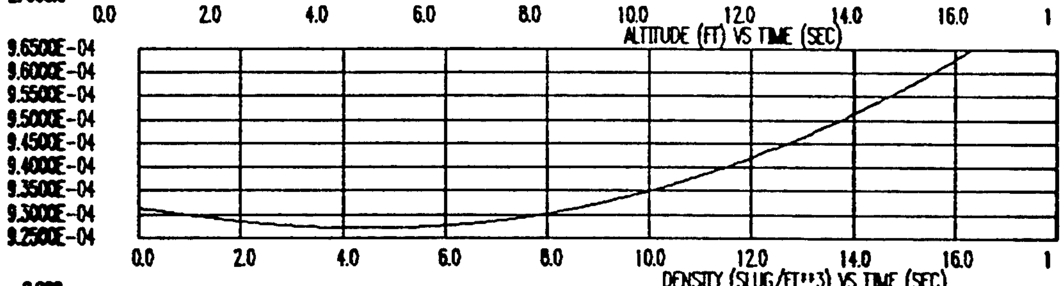

ROLL AERO MOMENT (FT-LB) VS TIME (SEC)
PITCH AERO MOMENT (FT-LB) VS TIME (SEC)
YAW AERO MOMENT (FT-LB) VS TIME (SEC)
CREW X ACCEL (G) VS TIME (SEC)
CREW Y ACCEL (G) VS TIME (SEC)
CREW Z ACCEL (G) VS TIME (SEC)

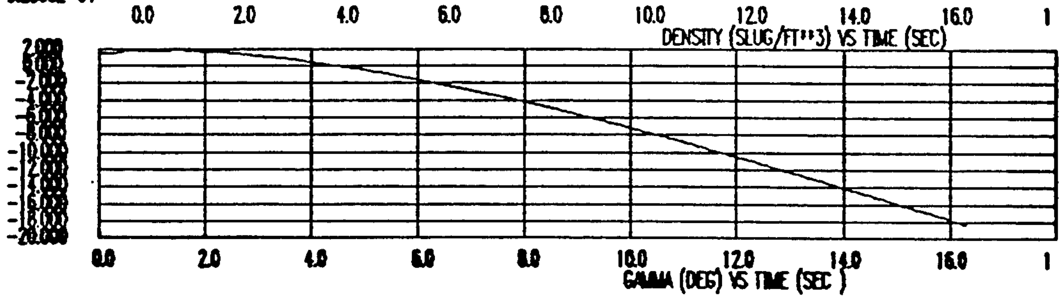

0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 9
CREW X ACCEL RATE (G/S) VS TIME (SEC)
6.0000
4.0000
2.0000
0.0000
-2.0000
-4.0000
-6.0000
-8.0000
0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 9
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
6.000
2.000
-2.000
-6.000
-10.000
-14.000
-18.000
-22.000
0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 9
CREW Z ACCEL RATE (G/S) VS TIME (SEC)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 9
CREW TOTAL ACC (G) VS TIME (SEC)
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 9
CREW TOTAL ACC RATE (G/S) VS TIME (SEC)

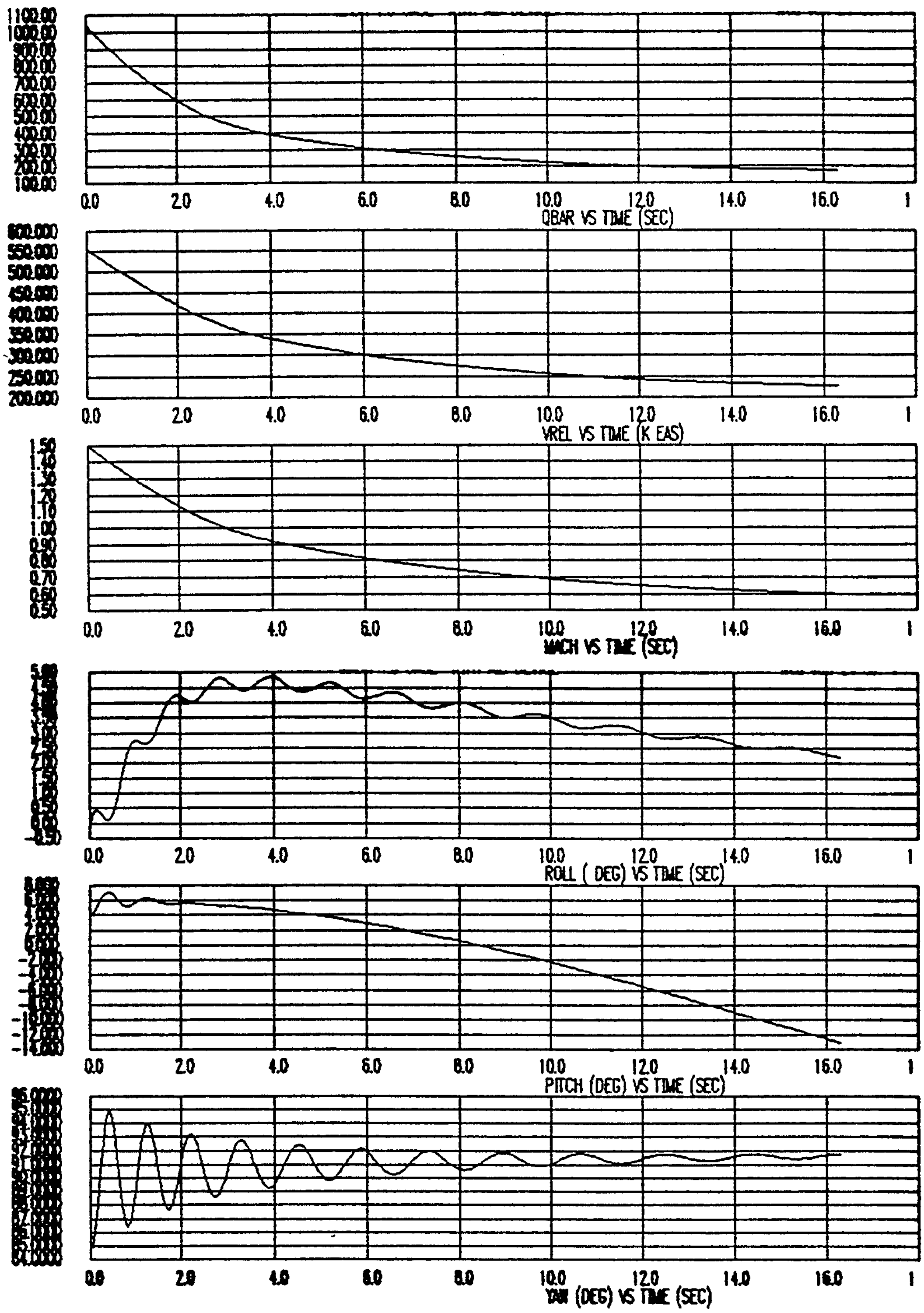

ALPHA (DEG) VS TIME (SEC)

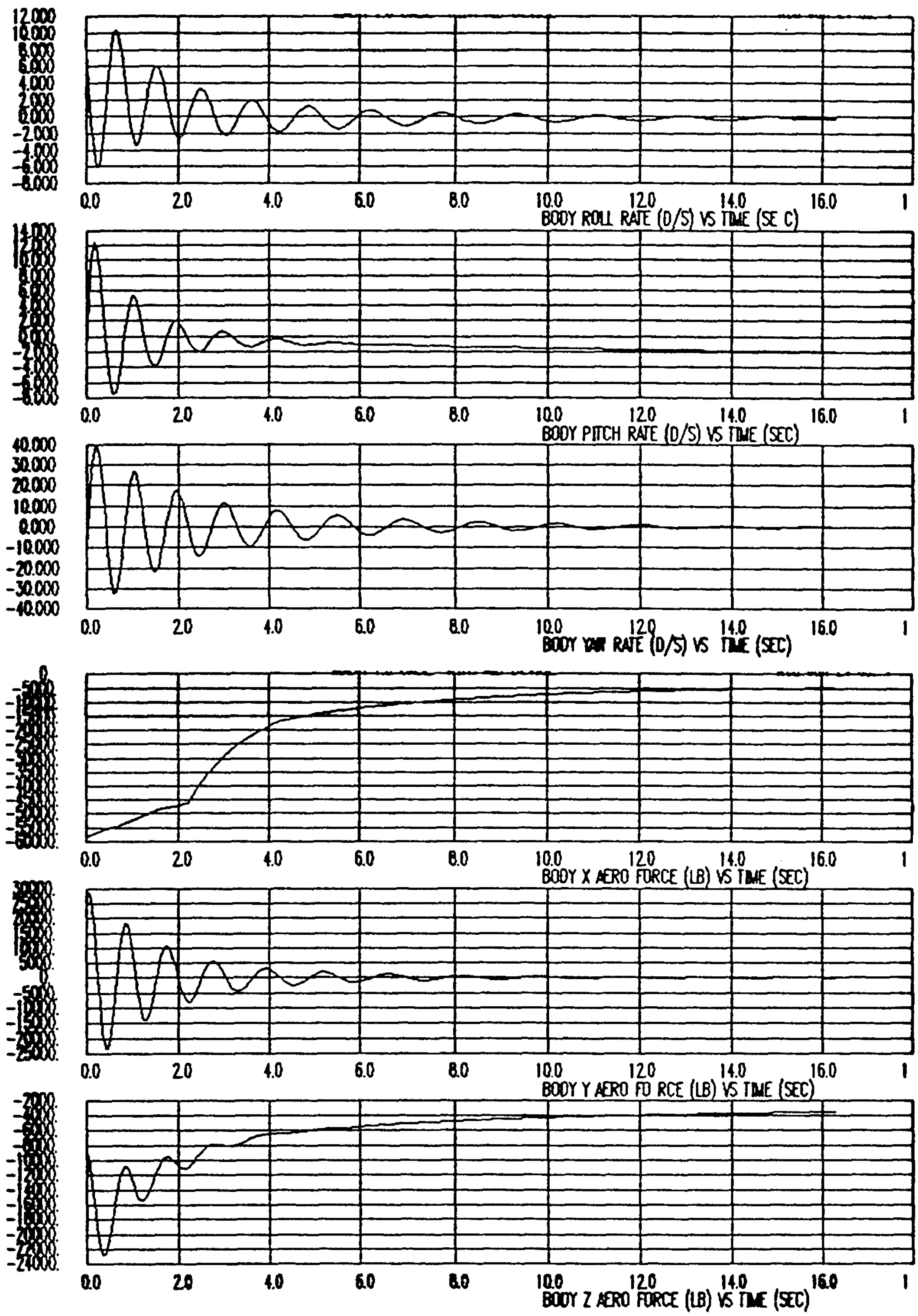

BETA (DEG) VS TIME (SEC)

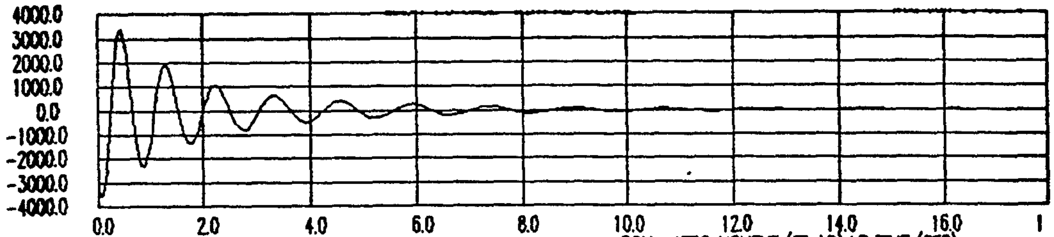

ALTITUDE (FT) VS TIME (SEC)


DENSITY (SLUG/FT**3) VS TIME (SEC)

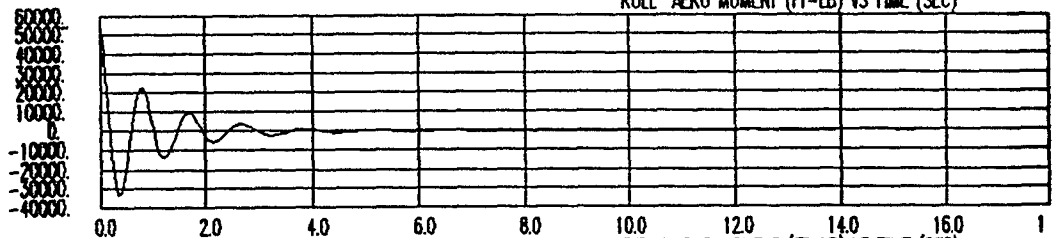

GAMMA (DEG) VS TIME (SEC)


QBAR VS TIME (SEC)
VREL VS TIME (K EAS)
MACH VS TIME (SEC)
ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)

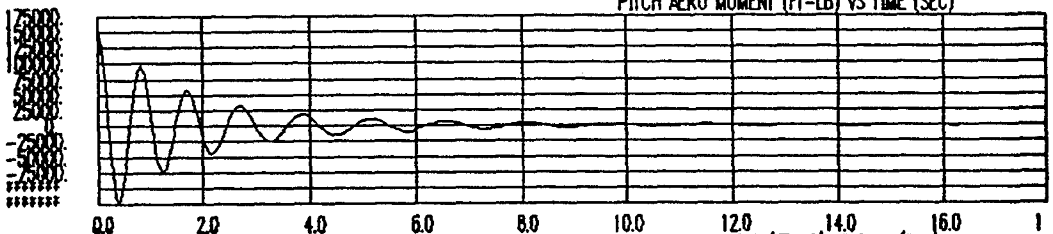

BODY ROLL RATE (D/S) VS TIME (SE C)
BODY PITCH RATE (D/S) VS TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)
BODY X AERO FORCE (LB) VS TIME (SEC)
BODY Y AERO FO RCE (LB) VS TIME (SEC)
BODY Z AERO FORCE (LB) VS TIME (SEC)



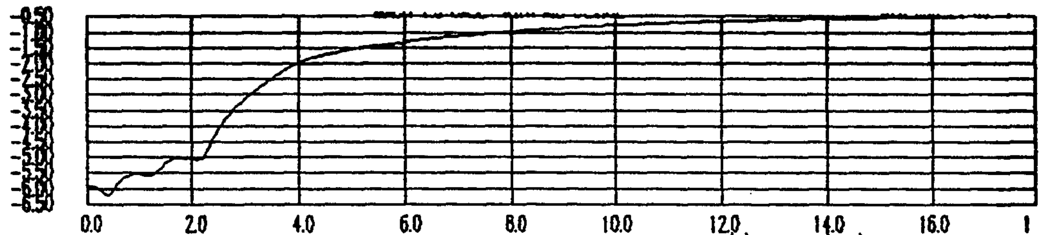
ROLL AERO MOMENT (FT-LB) VS TIME (SEC)



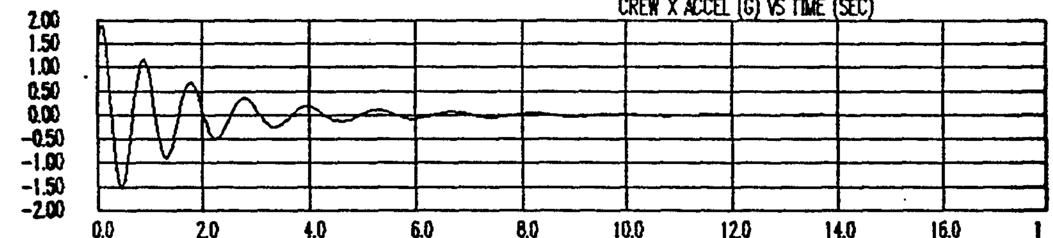
PITCH AERO MOMENT (FT-LB) VS TIME (SEC)



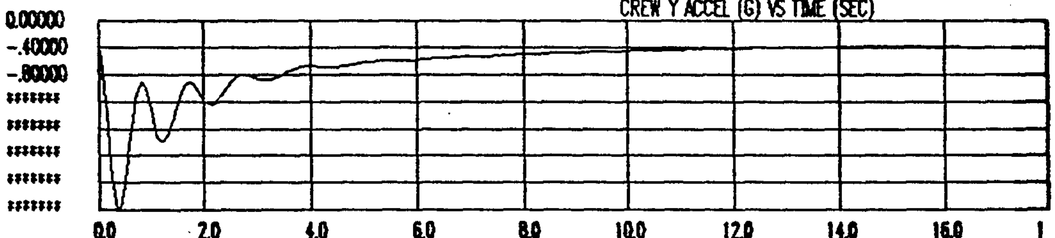
YAW AERO MOMENT (FT-LB) VS TIME (SEC)



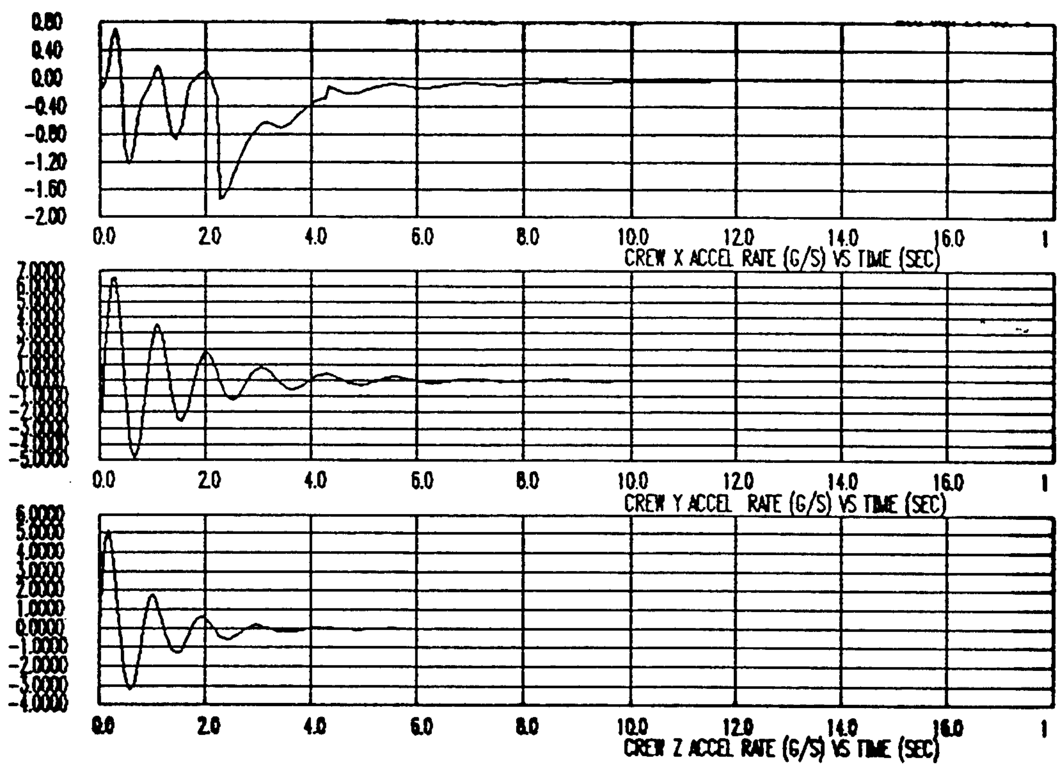
CREW X ACCEL (G) VS TIME (SEC)



CREW Y ACCEL (G) VS TIME (SEC)

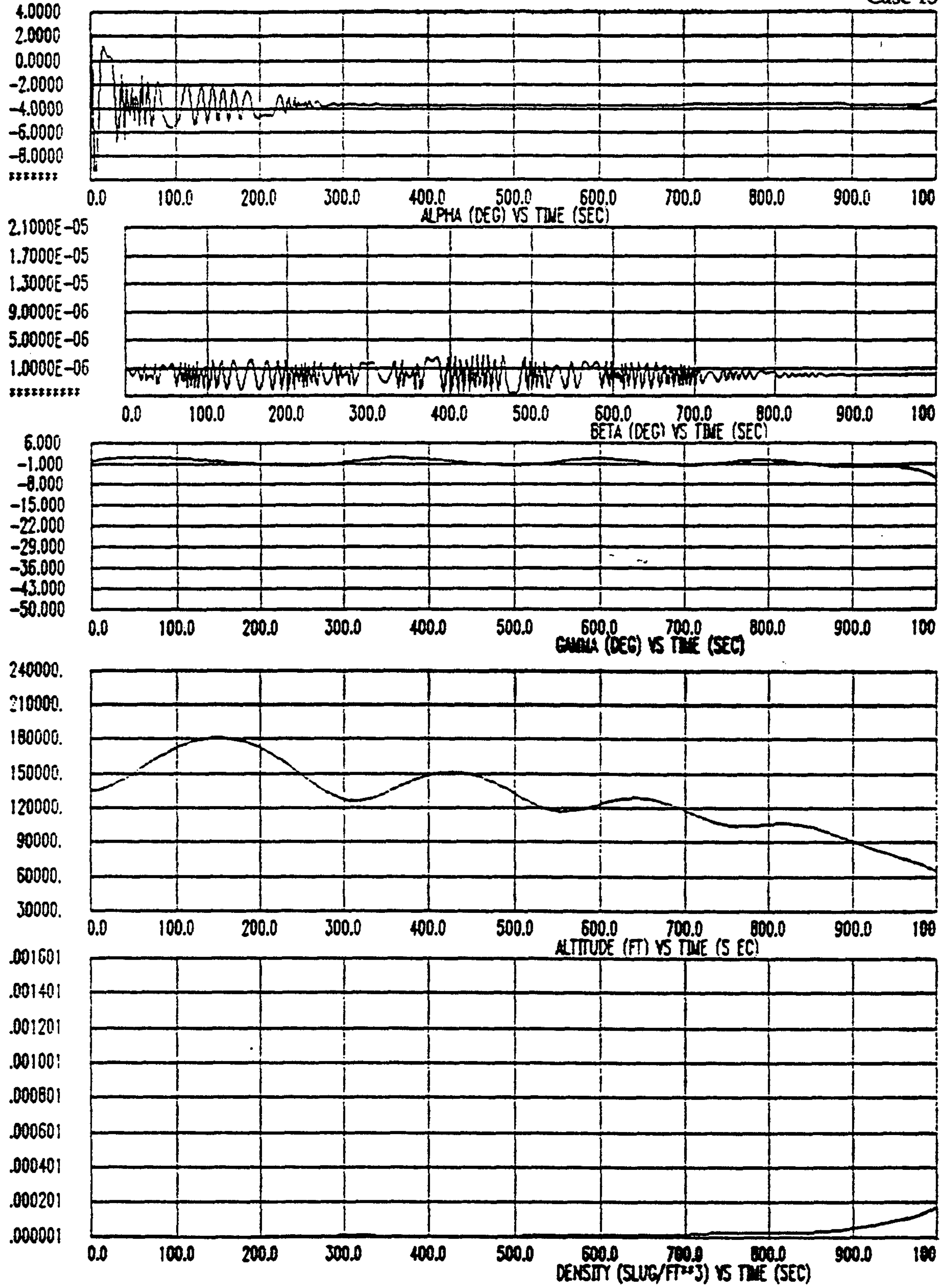


CREW Z ACCEL (G) VS TI ME (SEC)

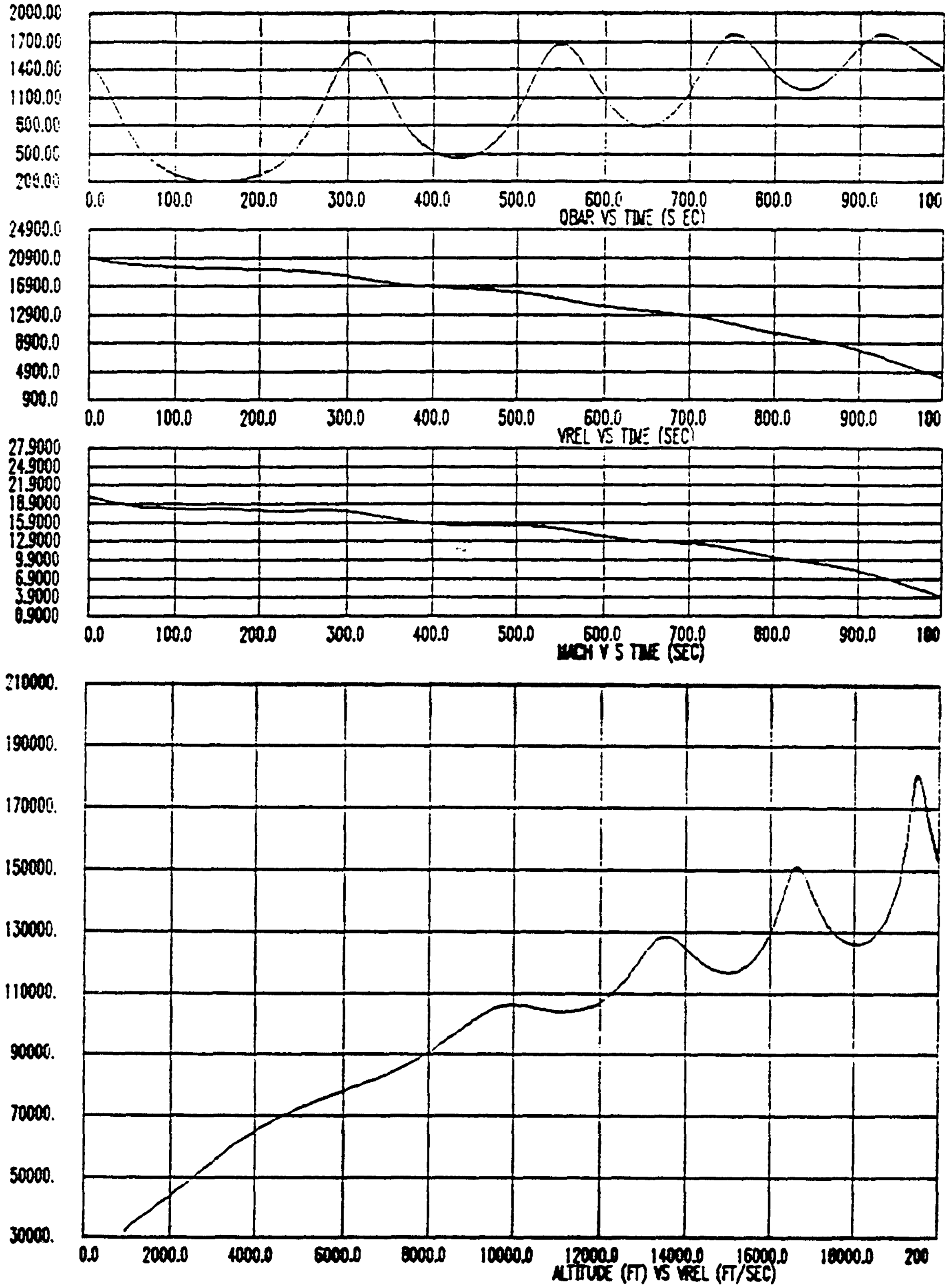


CREW X ACCEL RATE (G/S) VS TIME (SEC)
CREW Y ACCEL RATE (G/S) VS TIME (SEC)
CREW Z ACCEL RATE (G/S) VS TIME (SEC)

Case 13

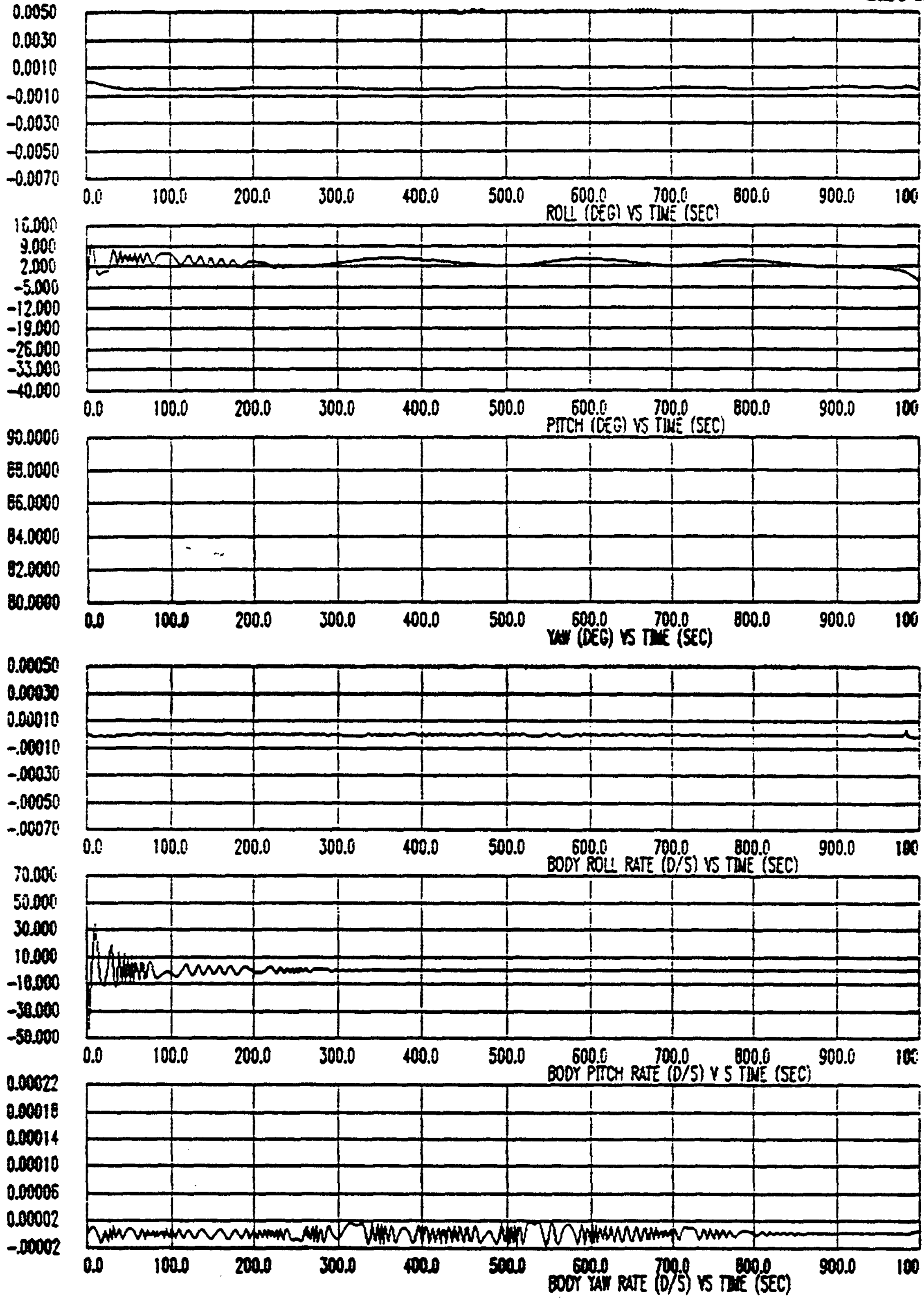

4.0000
2.0000
0.0000
-2.0000
-4.0000
-6.0000
-8.0000
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
ALPHA (DEG) VS TIME (SEC)
2.1000E-05
1.7000E-05
1.3000E-05
9.0000E-06
5.0000E-06
1.0000E-06
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
BETA (DEG) VS TIME (SEC)
6.000
-1.000
-8.000
-15.000
-22.000
-29.000
-36.000
-43.000
-50.000
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
GAMMA (DEG) VS TIME (SEC)
240000.
210000.
180000.
150000.
120000.
90000.
60000.
30000.
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
ALTITUDE (FT) VS TIME (S EC)
.001601
.001401
.001201
.001001
.000801
.000601
.000401
.000201
.000001
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
DENSITY (SLUG/FT**3) VS TIME (SEC)

Case 13

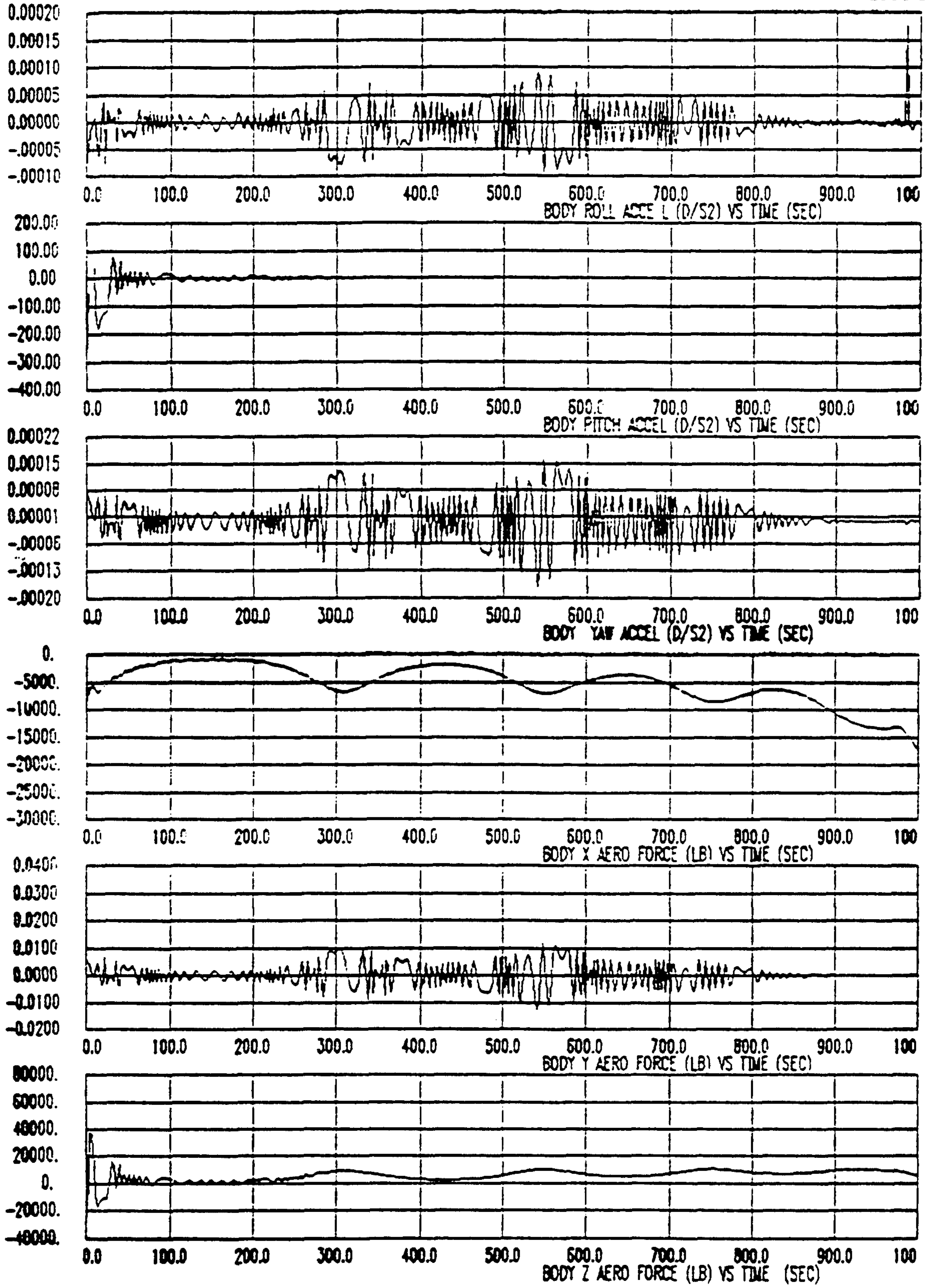


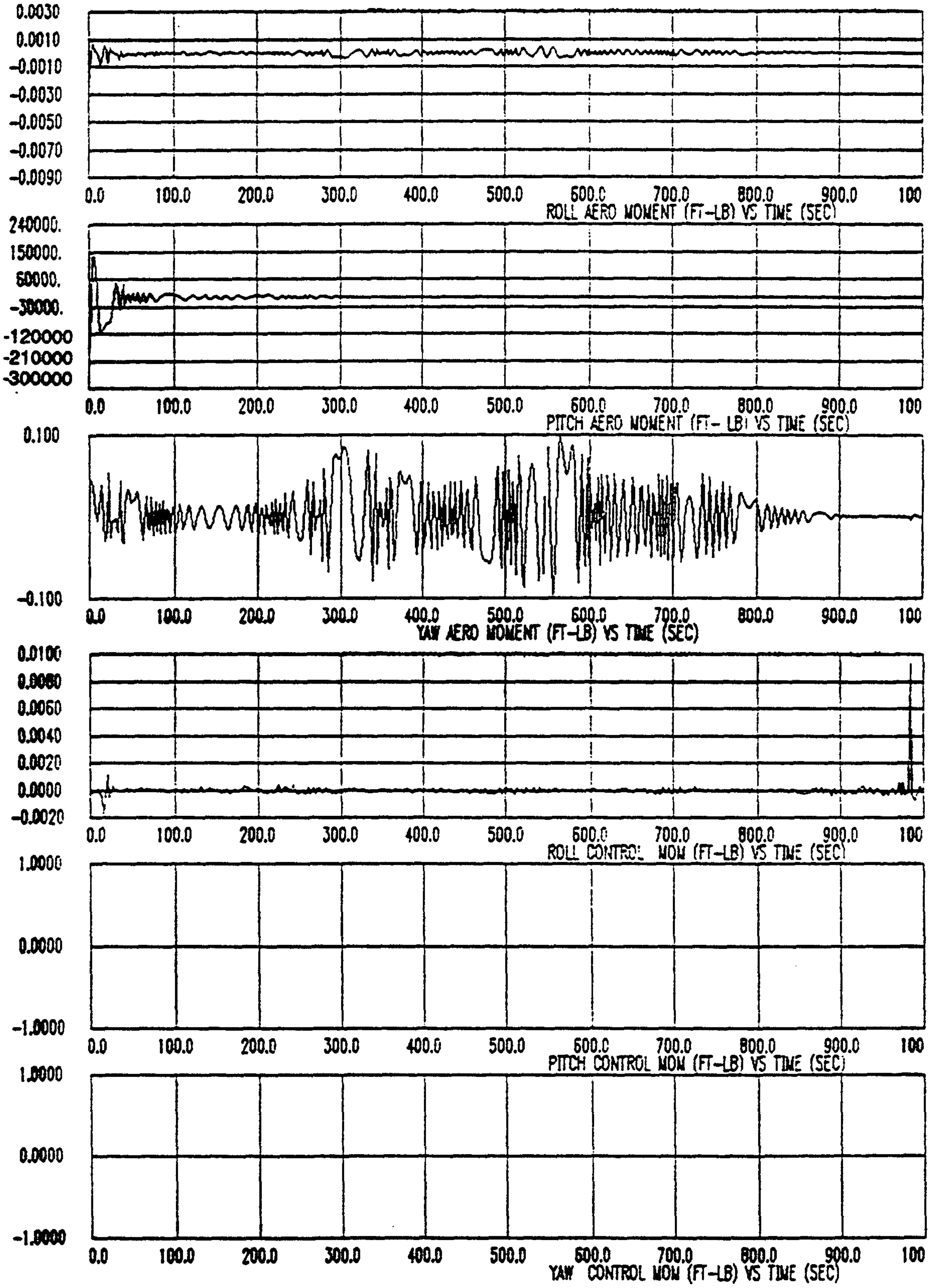
QBAR VS TIME (SEC)
VREL VS TIME (SEC)
MACH VS TIME (SEC)
ALTITUDE (FT) VS VREL (FT/SEC)

Case 13

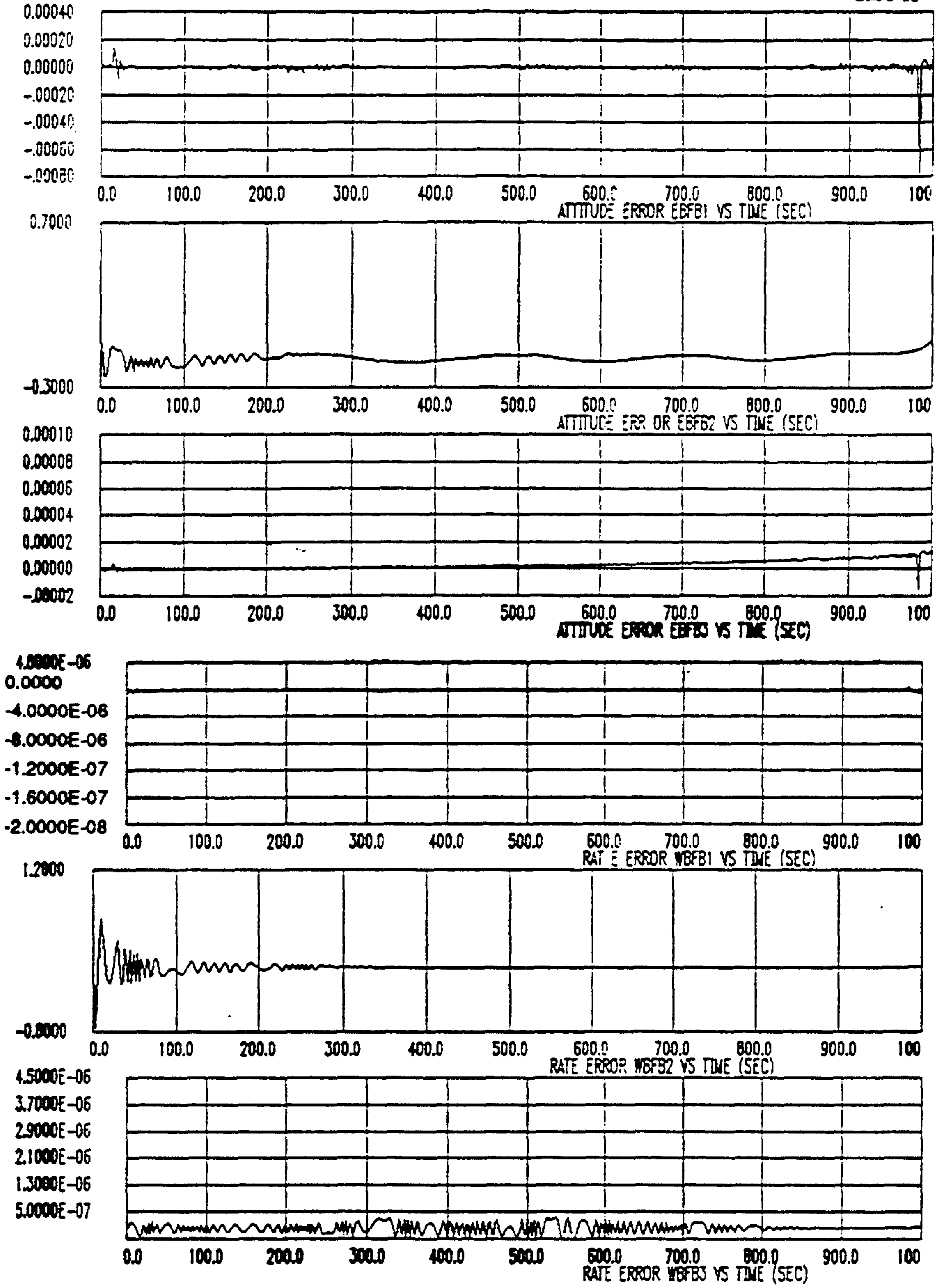

ROLL (DEG) VS TIME (SEC)
PITCH (DEG) VS TIME (SEC)
YAW (DEG) VS TIME (SEC)
BODY ROLL RATE (D/S) VS TIME (SEC)
BODY PITCH RATE (D/S) V S TIME (SEC)
BODY YAW RATE (D/S) VS TIME (SEC)

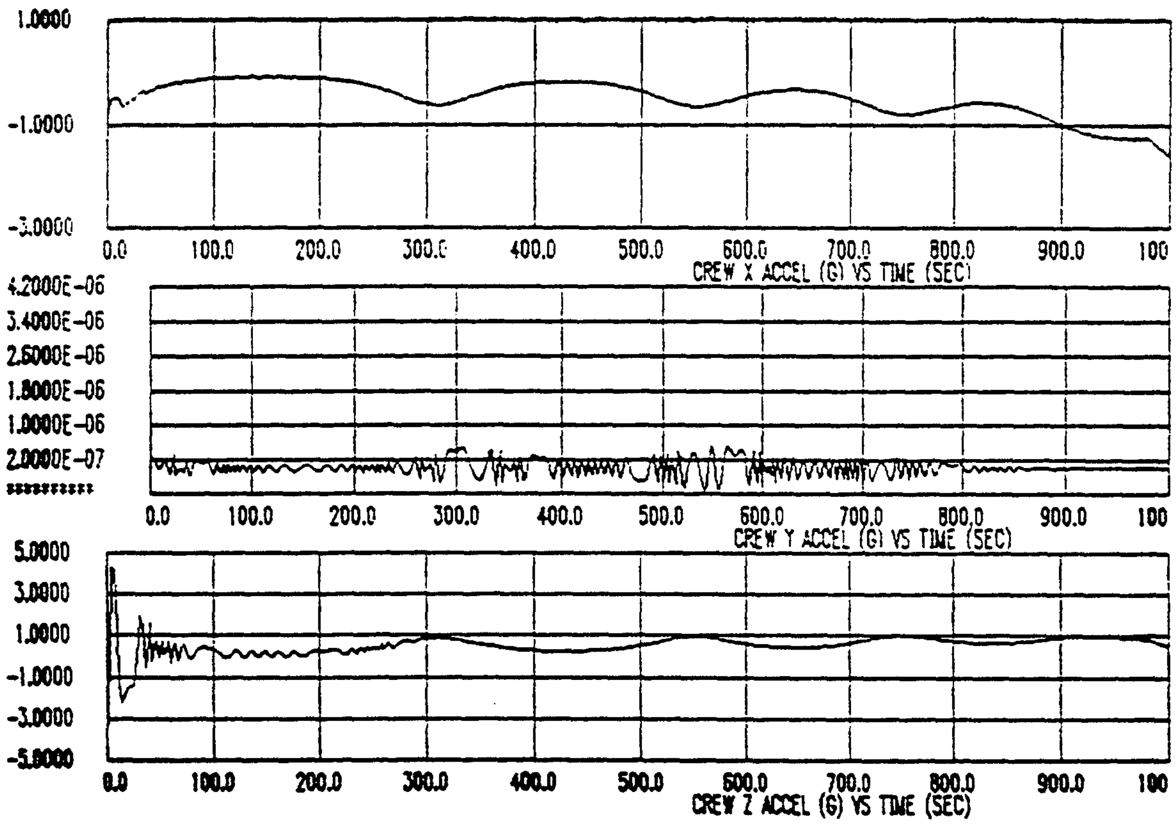
Case 13


BODY ROLL ACCEL (D/S2) VS TIME (SEC)
BODY PITCH ACCEL (D/S2) VS TIME (SEC)
BODY YAW ACCEL (D/S2) VS TIME (SEC)
BODY X AERO FORCE (LB) VS TIME (SEC)
BODY Y AERO FORCE (LB) VS TIME (SEC)
BODY Z AERO FORCE (LB) VS TIME (SEC)


ROLL AERO MOMENT (FT-LB) VS TIME (SEC)
PITCH AERO MOMENT (FT- LB) VS TIME (SEC)
YAW AERO MOMENT (FT-LB) VS TIME (SEC)
ROLL CONTROL MOM (FT-LB) VS TIME (SEC)
PITCH CONTROL MOM (FT-LB) VS TIME (SEC)
YAW CONTROL MOM (FT-LB) VS TIME (SEC)
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100

Case 13


0.00040
0.00020
0.00000
-.00020
-.00040
-.00060
-.00080
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
ATTITUDE ERROR EBFB1 VS TIME (SEC)
0.7000
-0.3000
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
ATTITUDE ERR OR EBFB2 VS TIME (SEC)
0.00010
0.00008
0.00006
0.00004
0.00002
0.00000
-.00002
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
ATTITUDE ERROR EBFB3 VS TIME (SEC)
4.0000E-06
0.0000
-4.0000E-06
-8.0000E-06
-1.2000E-07
-1.6000E-07
-2.0000E-08
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
RAT E ERROR WBFB1 VS TIME (SEC)
1.2000
-0.8000
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
RATE ERROR WBFB2 VS TIME (SEC)
4.5000E-06
3.7000E-06
2.9000E-06
2.1000E-06
1.3000E-06
5.0000E-07
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
RATE ERROR WBFB3 VS TIME (SEC)


1.0000
-1.0000
-3.0000
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
CREW X ACCEL (G) VS TIME (SEC)
4.2000E-06
3.4000E-06
2.6000E-06
1.8000E-06
1.0000E-06
2.0000E-07
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
CREW Y ACCEL (G) VS TIME (SEC)
5.0000
3.0000
1.0000
-1.0000
-3.0000
-5.0000
0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 900.0 100
CREW Z ACCEL (G) VS TIME (SEC)

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 88TH AIR BASE WING (AFMC)
WRIGHT-PATTERSON AIR FORCE BASE OHIO

MEMORANDUM FOR: DTIC – OQ
Attn: Larry Downing
8725 John J. Kingman Rd.
Ft. Belvoir VA 22060

3 March 2005

FROM: 88 CG/SCCM (FOIA Office)
Bldg 1455
3810 Communications Blvd
WPAFB OH 45433

SUBJECT: Freedom of Information Act (FOIA) Case, WPAFB FOIA Control # 05-098LK

1. On 16 Nov 2004, we received a FOIA request for document ADB 236817, "National Aerospace Plan Special Study on Crew Escape Phase IV, Vol 2, Final Report, R.E. Zegler, A.Bermudez, Jul 1990, 254 pp. Rockwell Intl." The current distribution statement B (unclassified/limited) is no longer applicable. The document has been reviewed by The Air Force Research Lab Human Effectiveness Directorate, (AFRL/HE) and it has been determined that the distribution statement should be changed to statement A (publicly releasable).

2. I am the point of contact and can be reached at (937) 522-3091 or DSN 672-3091.

Lynn Kane

Lynn Kane
Freedom of Information Act Analyst
Management Services Branch
Base Information Management Division

Attachment
AFMC Form 559
AFMC Form 556
FOIA Request